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TROPICAL AGRICULTURE:

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WASTE NOT, WANT NOT!

EFFECT OF PASTEURIZATION ON NUTRITIVE QUALITIES OF MILK.

HISTORY AND CULTIVATION OF THE TONKA BEAN (*DIPTERYX ODORATA*) WITH ANALYSES OF TRINIDAD, VENEZUELAN AND BRAZILIAN SAMPLES

INVESTIGATION AND SELECTION IN THE OIL PALM.

PRICE 6d.

R.C.W. 1925.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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WASTE NOT, WANT NOT!

THE past few years have seen a widespread campaign against waste in every sphere of human activity, and it is not surprising that the agriculturist is at last beginning to realise what a potential source of plant-food is being wasted through the methods adopted by town authorities in the disposal of their street and household refuse.

The commonest method, where this material cannot be carried out to sea, is to dump it in some remote spot. Not only is this method expensive, but such a dump is a potential source of infection, and this implies the ever-present danger of typhoid and other infectious diseases. Covering the refuse-dump with earth adds to the expense, and has not been shown to be effective, in preventing infection. The only other method of dealing with refuse is by incineration, but this is costly, even where the calorific value of the refuse is very high, and as it seems a fact that this value is generally falling, owing to the increasing use of gas and electricity for heating and cooking, destruction by incineration will become an increasingly difficult problem.

Agriculturists will, therefore, welcome information about a new process which has now received sufficient trial to warrant its adoption on a commercial scale, for not only does it provide a safe and clean method for the disposal of house and street wastes, but it turns them into a valuable manure. The original process was the invention of Dr. N. Boggiano Pico, an Italian scientist and was first operated at Reggio-Calabria in 1932, under the immediate control of Commander L. Boggiano Pico, a relative of the inventor. Briefly, the process, which has been modified and improved since the original installation, consists of an anaerobic fermentation followed by an aerobic fermentation. After a preliminary separation of cinders, metal and glass, the material is sprayed with a fluid culture of bacteria and dumped into a concrete cell which is sealed as soon as it is filled. After seven days, air is pumped through the mass by means of pipes and an aerobic fermentation then proceeds for a further seven days, when the process is complete. The material is discharged into a machine where it is finely disintegrated, and turned out as a fibrous cellular mass easily handled and with no unpleasant attributes. It possesses considerable manurial value, but this naturally depends largely on the proportion of moisture it contains.

The process was referred to in 1934 by Sir Frank Stockdale in his report on the conditions of agriculture in the Maltese islands, as likely to suit the needs of Malta, but interest will be heightened by the information that an installation has recently been erected for the Kensington Borough Council to deal with a daily collection of about 300 tons of refuse. From this quantity it is expected to obtain 40 tons of manure which it is hoped will be worth in the neighbourhood of a pound a ton.

The progress of this experiment will be watched with great interest, for if it succeeds, it will be the forerunner of many more. It is not the first time that a municipality has endeavoured to convert its rubbish into manure. Maidenhead, for many years, has been running a plant for this purpose, but followed the old idea of heavy inoculation and natural aerobic fermentation throughout, and this requires a large area for the installation, for the process takes some time and the heaps have to be kept small. The advantages of the new system are a great saving in time and space, more complete mechanisation, and much more rigid hygienic control, and it is claimed that a factory can be erected even in a residential neighbourhood, without any nuisance being caused to the inhabitants.

The value of such a source of organic manure to the farming and gardening industry, does not need to be emphasised in an Agricultural Journal, but it is possible that such an ' activated ' manure may have a value above what is shown by chemical analysis. There is no doubt that excessive use of chemical manures has in some cases brought about a dangerous loss of humus in the soil, and a consequent loss of soil structure, and there is no limit to the extent to which this manure could be utilised alone or in combination with chemical manures, in maintaining fertility.

The process is of course protected by patents, which are held by a London Company (1). A British subsidiary company (2) was formed last year, and constructed an experimental plant in London, which was sufficiently successful to induce the Kensington Borough Council, to accept a contract as mentioned above, for twenty years. A number of other municipalities are reported to be interested, and it is likely that considerable development may take place in the near future.

Towns in the tropics do not offer the same prospects of success from their smaller size and more scattered population, but they have the advantage that the rubbish they produce is in some cases particularly rich in organic matter and suitable for treatment. The need for organic manure in the tropics—is as great—greater, where conditions are unsuitable for keeping animals—and it will be interesting to see which tropical town will be the first to introduce this or some similar method of producing " Agricultural Wealth from Waste (3)".

R.C.W.

References.

1. Messrs. Wellesley Holding Ltd., Duke Street, St. James, London.
2. Hyganic Limited.
3. *Tropical Agriculture*, XI, 69.

THE RELATION OF GROWTH SUBSTANCES TO HORTICULTURAL PRACTICE.*

Much of our recent knowledge of plant hormones we owe to the Utrecht botanists, whose investigations led to the recognition of the nature and function of these substances. Earlier experiments carried out with seedling oats showed that the shoot apex produced substances capable of regulating growth, and that these substances could be transferred to other seedlings. A wide search was consequently made for a ready source of these compounds and they have since been found in small quantity in grain, pollen and leaves, while higher concentrations occur in urine.

At the Leicester meeting of the British Association, Prof. F. Kögl described the isolation and chemical recognition of auxin *a* and *b*. Their structure is complicated, but with these two compounds a third active compound, hetero-auxin, was found which proved to be indolyl-acetic acid, previously well known to chemists.

Small quantities (5 mgm.) of indolyl-acetic acid, when applied in lanolin to the young stems of tomato plants growing vigorously, cause, within 24 hours, twisting and bending of the petioles and stems, as unequal growth takes place on the two sides. This is a quick ready means of testing closely-related and other chemical growth-promoters. In a few days, roots appear from the stem, root-initials also develop inside, and may be clearly seen by cutting the stem longitudinally. Similarly, the production of roots may be induced in several different portions of plants, and vegetative reproduction is thus greatly facilitated.

The paste method has been largely superseded by the use of dilute solutions. Herbaceous or woody cuttings are taken and their basal ends placed in the solution to a depth of an inch. After washing in water, the cuttings are then placed in sand in propagating frames.

The list of active growth-promoting substances includes the related indolyl-butyric and indolyl-propionic acids. The organic salts or esters of these acids are active, so are some of their metallic salts, such as sodium indolyl-acetate. Scatole also has recently been proved to be active, and alpha- and beta- naphthalene-acetic acid are very highly active, but phenyl-acetic acid and anthracene-acetic acid are less active. Although fairly closely related, iso-indolinone is inactive. The

* Substance of a lecture by Dr. M. A. Tincker to Section K (Botany) of the British Association, and published in *Nature*, Vol. 140, No. 3544, 1937, from which it was adapted.

substitution of sulphur for the nitrogen and hydrogen group in indolyl-acetic acid greatly reduces the activity. Though closely related to indolyl-propionic acid, tryptophan is inactive; it may represent a stage in the formation of the growth-promoting substances in Nature.

The treatment causes (*a*) more cuttings to form roots; (*b*) more roots to be formed on each cutting; (*c*) the active process (including *a* and *b*) to be accelerated.

Amongst herbaceous plants, cuttings of lupins, delphiniums, pelargoniums, violas and alpine phlox have shown accelerated rooting by treatment with pastes in lanolin and with very weak solutions. There is a tendency to damage delicate tissue by the use of solutions of too high a concentration; 1 part in 30,000 or 40,000 parts of water is recommended for such cuttings.

With holly, taken at the end of June and treated with indolyl-acetic acid, 1 part in 10,000 of water for 24 hours, half the cuttings rooted in 6 weeks, while none of the controls, placed in water for 24 hours, rooted in this time. With *Viburnum Carlesii*, cuttings taken at the end of July and treated with alpha-naphthalene-acetic acid and others with indolyl-acetic acid, 1 part in 10,000 of water for 24 hours, rooting took place rapidly. In ten days, the active growth taking place inside the stem split the outer layers. Cuttings of *Ceanothus dentatus*, taken in late November, produced roots in January, and *Myrtus communis* cuttings, taken in January, rooted in a month. Stimulation may occur at a season of normal quiescence.

Species and varieties of heather (*Erica*) responded quickly to alpha-naphthalene-acetic acid; *Pieris formosa*, taken in late August, and *Gaultheria procumbens*, have given favourable results. With *Rhododendron rubiginosum*, 85 per cent. of the cuttings treated in alpha-naphthalene-acetic acid and indolyl-acetic acid, 1 in 20, 000 for 48 hours, rooted in three months, whilst only 5 per cent. of the controls form roots. Other plants tested include species of *Buddleia*, *Camellia*, *Deutzia*, *Escallonia*, *Hydrangea*, *Pernettya*, all of which showed favourable results by these methods. Even with the more recalcitrant genera and species, some encouraging results have already been obtained. Further results are reported in tests made by horticultural and chemical firms, and at various research stations and laboratories. These greatly extend the list of species in which root formation has been accelerated. Certain species may yet prove quite unresponsive, but the indications are to the contrary, provided the time of year and concentration of solution are correctly selected.

The concentrations are surprisingly low; frequently 1 in 40,000 of water is effective. It appears that there is a critical concentration below which little or no activity is induced. Twice the length of time for uptake from a solution half as concentrated may not be so effective as a stronger solution used for the given time.

Pouring the solutions onto the sand before inserting cuttings is *not* recommended, as bacteria interfere. Freshly made solutions should be used, because moulds and bacteria may contaminate them on storing. Since the solutions are not stable in light, storage in coloured and opaque vessels at higher concentration is recommended.

The success obtained has been quickly appreciated by chemists, manufacturers, and by horticulturists. There are now a number of solutions available on the market in many countries.

Thus it is seen that investigations, primarily of botanical interest, dealing with fundamental problems of plant development, have quickly led to results of great value to the plant grower.

EFFECT OF PASTEURIZATION ON NUTRITIVE QUALITIES OF MILK.

The annual report for 1936 of the National Institute for Research in Dairying, University of Reading, recently issued, contains summaries of two researches carried out at the Institute upon the effect of pasteurization upon the nutritive qualities of milk. In one experiment, shorthorn bull calves when 4-5 days old were grouped in pairs of similar age and weight, and one of each pair, chosen by lot, received raw, and the other pasteurized, milk until the completion of the experiment twenty-six weeks later. The milk diet was supplemented from the ninth week onwards with a little hay, and from the seventeenth week with a small allowance of crushed oats and flaked maize. Records were kept of the food consumed, the live weight gains, general appearance of the animals and other relevant matters. Eleven pairs completed the experiment, and no material difference could be detected between the two groups. The average daily live-weight gain per head for the calves receiving raw milk were 1.967 lb., for those receiving pasteurized milk 1.969 lb. Another study was on the effect of commercial pasteurization upon the nutritive value of milk. The raw and pasteurized milks were from the same bulk, the experiments being carried out on rats. No marked loss in the value of milk as food which could be attributed to commercial pasteurization could be detected. One-fifth of the vitamin C content of raw milk is lost in the course of commercial pasteurization, but this is partly due to exposure to light. Milk exposed in a bottle in the sun for half an hour loses half its original anti-scorbutic properties.—(*Nature*, Vol. CXL, No. 3533, pp. 115-16, 1937.)

The Late Mrs. J. R. DICKSON.

The sympathy of all members of the College goes to Dr. J. R. Dickson, O.B.E., M.B., B.Sc., D.P.H., Medical and Health Officer, in the loss of his wife, whose death took place at Brighton, England, on the 26th December, 1937.

HISTORY AND CULTIVATION OF THE TONKA BEAN (*DIPTERYX ODORATA*) WITH ANALYSES OF TRINIDAD, VENEZUELAN AND BRAZILIAN SAMPLES.

By F. J. Pound,
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(*Continued from Tropical Agriculture*, XV, No. 1.)

Imports and Exports.

During the past ten years the exports of cured Tonka beans produced in Trinidad have risen by 900 per cent. (Table I).

Table I.

Year.	Exports.	Value.
	lb.	£
1927	10,015	1,669
1928	884	147
1929	15,266	2,544
1930	9,219	1,538
1931	22,950	3,583
1932	69,276	12,993
1933	9,979	3,004
1934	45,450	14,822
1935	37,968	12,320
1936	92,719	31,002

In addition, beans from South America are imported for curing and transhipment; the statistics of these are given in Table II.

Table II.

Imports of Tonka Beans for Transhipment.

Year.	Imports.	Value.
	lb.	£
1927	72,183	11,674
1928	50,729	7,555
1929	423,138	64,834
1930	52,174	9,340
1931	560,847	72,262
1932	217,737	31,507
1933	36,185	7,153
1934	925,078	271,546
1935	59,926	16,802
1936	838,700	203,137

The bulk, if not all, of these beans is sent from Venezuela but recently there have been small imports of Brazilian beans, since the curing of Venezuela beans is now being done in Venezuela before export. The Brazilian beans probably belong to a different variety of *Dipteryx* as they are shorter and broader than the Trinidad beans.

Commercial Uses.

Tonka beans are chiefly used for flavouring tobacco, and the bulk of the exports are shipped to the United States for that purpose. The beans are also utilised in various perfumery preparations, in confectionery, and also in liqueurs such as benedictine. No reliable information appears to be available as to the extent to which the beans are used for any of these purposes, and such particulars would be difficult to obtain, as recipes for perfumery and flavouring agents are usually well-guarded secrets, and users of Tonka beans do not advertise that they are employing them in their manufactures.

There are no indications that the demand for Tonka beans in the United Kingdom is likely to expand. Two commercial varieties are recognised by the trade, viz.: the Angostura and Venezuela beans, as exported through Trinidad, and the Para or Brazilian beans. The former, chiefly because they are cured in rum and are larger, are the more highly valued and realise the best prices, the 1936 value of Angostura beans in London was about 8*s.* 6*d.* per lb. against about 3*s.* per lb. for the Para beans.

Trade enquiries indicate that the market for Tonka beans is erratic. A few years ago, for instance, when the price of the Para beans was only 6*d.* per lb., the demand was small, but when the price subsequently rose to 1*s.* 6*d.* per lb., a good market was found for the product. The increased demand may have caused this rise in price. The Imperial Institute report states that at the present time, owing to the high prices now obtainable for Tonka beans in the United States, the demand in the United Kingdom has fallen off.

The bulk of the exports from Trinidad go to the United States, which in 1934 imported nearly 14 times as much as in 1933.

Curing Process.

Usually at the merchant's store the fresh beans are cured by soaking in strong rum for several days. The rum is then drained off, leaving the tightly packed beans in the barrel ready for export. After this is done, there soon appears on the surface of the beans a white-needle crystalline deposit of coumarin which is said to be the important constituent of the bean.

Treatment with Alcohol.

Although coumarin is readily soluble in absolute alcohol, its solubility falls very rapidly as the strength of the alcohol is lowered. The alcohol content of the rum or spirit employed in the process of curing the beans is stated to be from about 45 to 65 per cent. by volume. At 61° to 63°F. only about two parts of coumarin are soluble in 100 parts of 45 per cent. alcohol, but about 7.3 parts are soluble in 100 parts of alcohol of the strength of 65 per cent. by volume. There should, however, be small risk of losing any appreciable amount of the coumarin in the alcohol, especially if the surplus spirit from one curing operation is used over again after being brought up to the required strength by the addition of strong rum or industrial spirit.

Coumarin.

It was at one time believed that on account of price differences, Venezuelan and Trinidad beans contained a much higher coumarin content than Brazilian beans but this is probably not so, for recent analyses from the Imperial Institute suggest

that there may be higher coumarin in the latter, showing that coumarin content is not the only factor which is taken into account by the trade.

The beans are employed for perfuming and flavouring purposes, and the aroma and flavour are thus of paramount importance. The trade, however, will only recognise beans which have the appearance and "handle" of those which have undergone the approved method of curing. Coumarin, which is mainly responsible for the characteristic odour of Tonka beans, is liberated from a glucoside present in the beans as a result of the action of a ferment (enzyme) also present. The splitting of the glucoside is understood to take place during the drying stage of the curing process; further decomposition changes are arrested by the subsequent treatment with alcohol which, moreover, takes into solution the coumarin which in part is deposited as the crystals on the surface of the beans when they are finally dried.

Tonka beans which are judged to be properly "cured" are somewhat pliable, and must show coumarin as a crystalline deposit on their surface. The beans, however, are not sold on a basis of coumarin content, and the trade employ no method for determining the actual amount of coumarin present in them. The buyers approve of well "crystallised" beans, and the greater the amount of coumarin present in the bean, the more readily is the required crystalline condition secured. Beans which have been soaked in rum are considered by the trade to have the best aroma and flavour, and it is therefore apparent that: (*a*) the approved aroma and flavour are not dependent entirely on the coumarin present, and (*b*) the use of rum develops the general aroma and flavour of the entire bean.

It is true that Tonka beans have been replaced to a considerable extent by synthetic coumarin, but they are still in demand. Artificial vanillin, as a substitute for vanilla pods, is another instance of a synthesized article which has largely superseded the natural product, but there is still a market for vanilla pods, which, although containing only two to three per cent. of vanillin, were quoted at 7*s*. 6*d*. to 15*s*. per lb. in London in 1936, with vanillin at 13*s*. to 14*s*. per lb. It is generally admitted that in both Tonka beans and vanilla pods, there are traces of other, so far unidentified, odoriferous substances which form a valuable contribution to the general aroma, whilst the synthesized compounds are devoid of these subsidiary fragrant substances and are, moreover, liable to contain traces of impurities which would detract from, rather than improve, the odour of the compound.

Analysis of Samples sent to Imperial Institute.

Trinidad and Venezuelan Samples.

Nineteen samples of uncured Tonka beans were forwarded to the Imperial Institute from the Trinidad Department of Agriculture in 1936. The samples were submitted for examination in connection with the consideration by the

Table III.

Statistics of Venezuelan and Trinidad Beans.

Sample.	Weight.	Colour.	General Appearance.
	Oz.		
T. 1—1st's	13	Dark reddish-brown. Fairly uniform in colour.	Wrinkled beans of glossy appearance.
T. 2—1st's	13½	Somewhat darker than T.1. Uniform in colour.	Similar to T.1.
T. 3—1st's	15	Some beans yellowish or orange-brown; others similar to T.2; others mixed in colour. Not uniform.	Similar to T.1.
T. 4—1st's	13½	Similar to T.2 in colour, but somewhat less uniform.	Somewhat less glossy than T.1.
T. 5—1st's	14½	Similar to T.2	Similar to T.4
T. 6—1st's	14½	In general similar to T.2 but a few beans somewhat paler. Otherwise uniform.	Somewhat less glossy than T.4.
T. 7—1st's	13½	Very slightly darker than T.2 Uniform.	Similar to T.6.
T. 8—1st's	13½	Similar to T.7.	Similar to T.4.
T. 9—1st's	12½	Similar to T.4, but rather less uniform.	Similar to T.6.
T.10—1st's	14	Similar to T.4.	Similar to T.6.
T.11—1st's	12½	Similar to T.2.	Similar to T.6.
T.12—1st's	11½	Dark reddish-brown but paler than preceding samples (except T.3). Uniform.	Similar to T.4.
T.13—1st's	14	Similar to T.2.	Similar to T.1.
T.14—1st's	12	Similar to T.12 but less uniform.	Similar to T.4.
T.15—2nd's	1½	Colour mixed. Similar to T.3.	Less glossy than T.6. Variable in size.
T.16—1st's	4½	Similar to T.2.	Similar to T.1.
T.17—2nd's	1½	Similar to T.12	Beans of glossy appearance but free from wrinkles. Plump.
V. 1—1st's	13½	Similar to T.3, but less mixed in colour.	Similar to T.1. A few beans similar to T.17.
V. 2—2nd's	6½	Darker than T.7, in fact darkest of series. Fairly uniform.	Similar to T.15, and very variable in size.

Department of Agriculture of (*a*) the difference in quality between Tonka beans grown in Venezuela and in Trinidad, and (*b*) the varying characters of beans from trees in different soils in the Colony and from individual trees. Seventeen of the samples had been collected from various areas in Trinidad, while the remaining two were of Venezuelan origin. Information was also required on the coumarin content of the samples, and their relative commercial value, for consideration in the selection of seed for planting.

The report from the Imperial Institute reads as follows :—

Description.—" Table III gives the weight, colour and general appearance of the samples as received at the Imperial Institute."

The average length, breadth and thickness of the beans in each sample, and their average weight, are shown in Table IV :—

Table IV.

STATISTICS OF VENEZUELAN AND TRINIDAD BEANS—(*Contd.*).

Sample.		Average Dimensions.			Average Weight.
		Length.	Breadth.	Thickness.	
		Cms.	Cms.	Cms.	Gms.
T. 1—1st's	Perseverance Estate, Maracas	4.1	1.2	0.7	2.3
T. 2—1st's	do. do.	3.4	1.2	0.7	2.0
T. 3—1st's	Tamana	3.8	1.2	0.7	2.0
T. 4—1st's	Matura	3.5	1.2	0.7	2.0
T. 5—1st's	Tierra Nueva Estate, Maracas	3.5	1.2	0.8	1.9
T. 6—1st's	do. do.	3.3	1.2	0.7	2.
T. 7—1st's	Diego Martin	3.8	1.2	0.8	2.8
T. 8—1st's	do.	4.0	1.2	0.8	2.8
T. 9—1st's	do.	3.8	1.2	0.7	2.2
T.10—1st's	do.	3.7	1.2	0.7	2.0
T.11—1st's	do.	3.8	1.2	0.7	1.9
T.12—1st's	Los Hermanos Estate, Biche	3.8	1.2	0.7	2.2
T.13—1st's	Sta. Barbara Estate, Toco	3.8	1.2	0.7	2.4
T.14—1st's	Maracas	3.5	1.1	0.6	1.9
T.15—2nd's	Grand View Estate, Manzanilla	3.4	1.1	0.6	1.7
T.16—1st's	Maracas	3.5	1.2	0.7	2.3
T.17—2nd's	Manzanilla	3.5	1.1	1.0	2.2
V. 1—1st's		3.8	1.1	0.6	2.2
V. 2—2nd's		3.5	1.0	0.7	1.8

Results of Examination.—The amounts of moisture and coumarin in the beans were determined with the following results (Table V) :—

Table V.

STATISTICS OF VENEZUELAN AND TRINIDAD BEANS—(*Contd.*).

Sample.		Coumarin.		
		Moisture.	Expressed on Beans as received.	Expressed on moisture-free Beans.
		Per cent.	Per cent.	Per cent.
T. 1—1st's	Perseverance Estate, Maracas	7.7	2.4	2.6
T. 2—1st's	do. do.	7.7	2.2	2.4
T. 3—1st's	Tamana	7.5	2.3	2.5
T. 4—1st's	Matura	8.4	2.2	2.4
T. 5—1st's	Tierra Nueva Estate, Maracas	7.6	1.9	2.1
T. 6—1st's	do. do.	8.5	2.2	2.4
T. 7—1st's	Diego Martin	7.8	1.9	2.1
T. 8—1st's	do.	7.9	2.0	2.2
T. 9—1st's	do.	7.9	2.9	3.1
T.10—1st's	do.	8.3	2.7	2.9
T.11—1st's	do.	8.2	2.7	2.9
T.12—1st's	Los Hermanos Estate, Biche	8.1	2.2	2.4
T.13—1st's	Sta. Barbara Estate, Toco	8.4	2.2	2.4
T.14—1st's	Maracas	8.2	1.9	2.1
T.15—2nd's	Grand View Estate, Manzanilla	7.6	2.9	3.1
T.16—1st's	Maracas	7.5	2.0	2.2
T.17—2nd's	Manzanilla	6.9	2.4	2.6
V. 1—1st's		7.8	2.5	2.7
V. 2—2nd's		7.8	3.2	3.5

Remarks.—"The present examination has shown that the amounts of coumarin in the 19 samples ranged from 2.1 to 3.5 per cent., expressed on the moisture-free material. The sample with the highest amount of coumarin was the Venezuelan product V.2, 2nd Grade. Another 2nd Grade sample, viz.: T.15, also gave a high figure. As regards general appearance, size and weight of beans, however, these samples were two of the smallest and least attractive of the series; and as the commercial value of Tonka beans depends on appearance as well as on aroma and flavour, it is evident that the coumarin content cannot be taken alone in selecting the most desirable type for propagation.

It must also be pointed out that the figures for coumarin content now reported represent the amounts of free coumarin present in the beans as received for examination. It is generally understood that coumarin forms in the growing bean in combination with other substances as a glucoside, and that it is set free from this combination during the drying of the beans, if not to some extent before. No detailed investigation of this subject appears to have been carried out, but it is reasonable to expect that the degree to which the glucoside is split up will depend on circumstances, and it is therefore probable that varying amounts of coumarin remain in combination as glucoside even in the cured and finished beans. It may also be expected that further lots of beans from the particular trees now under consideration, if dried under conditions varying slightly from the former drying period as regards time taken, temperature, and moisture content of the harvested beans, would furnish on analysis figures for free coumarin differing from those now recorded.

With regard to features of the present samples which would have a bearing on their market price, the beans were submitted to a firm in London, who have had considerable experience in handling Tonka beans, but as they represented uncured material (with which the trade is not familiar), the firm were unable to indicate any differences that would affect their commercial value. So far as could be judged from uncured beans, however, the firm expressed the opinion that if the Trinidad-grown samples were cured in the manner usual for Venezuelan beans, the former would, if as bold, be as good as the latter. In this connection the firm stated that the bolder, blacker, and more crystallised the cured beans are, the higher is their market value." (It so happens that the Venezuelan beans were cured in Trinidad at the time of this report.)

Brazilian Samples.

A sample of Brazilian beans was also recently sent to the Imperial Institute for examination and the report is reproduced below.

Description.—"The sample weighed 13 oz. and consisted of oval beans with a very wrinkled surface, which, as in the case of the previous samples of Tonka beans examined (*i.e.*, the Trinidad and Venezuelan samples above) was free from crystalline deposit. The present beans were more variable in size than the earlier samples, shorter on the average, plumper than all except sample T.17, and somewhat more rounded at the base. The colour was generally similar to that of the previous sample T. 1., *i.e.*, dark reddish-brown, though not quite so uniform, a few beans being paler and others darker."

Results of Examination.—The average dimensions and weight of the beans are shown in Table VI and should be compared with the figures obtained with the previous samples of Trinidad and Venezuelan beans. The amounts of coumarin and moisture in the sample were determined with the results shown in Table VII for comparison with those for the earlier samples.

Table VI.

Average Length Cms.	Average Breadth Cms.	Average Thickness Cms.	Average Weight Gms.
3.0	**1.2**	**1.0**	**2.0**

Table VII.

Moisture.	Coumarin expressed on Beans as received.	Coumarin expressed on moisture-free Beans.
Per cent. 10.2	Per cent. 2.4	Per cent. 2.7

Remarks.—"The results of examination show that the present sample of uncured Brazilian Tonka beans contains 2.7 per cent. of coumarin, expressed on the moisture-free material. This figure is higher than the average coumarin content (2.5) per cent. of the 17 samples of Trinidad beans previously examined and is only exceeded in the case of four of the latter samples, *viz.*: T.9, T.10, T.11, and T.15. In comparison with the two Venezuelan samples in the earlier set, the present sample of Brazilian beans contains a similar percentage of coumarin to V.1, but is not so rich in this constituent as V.2. It was, however, pointed out in the previous report that the figures recorded for the coumarin content represent free coumarin, and it is very probable that in the *cured* beans the percentage of free coumarin will differ from that found in the *uncured* beans. In connection with the selection of seed too great importance should therefore not be attached to the coumarin content of the uncured beans.

The beans of the present sample are plumper than any of the previous series excepting T.17 and if similar beans retain this advantage after

being cured, they should, *ceteris paribus*, have a higher market value. As stated in the earlier report, the market value of Tonka beans depends on their boldness, black colour, and crystallised appearance. The last-named character, and possibly the other two, depend upon the curing process, which exerts such an influence that it is very difficult to forecast the relative values of a series of samples of *cured* Tonka beans from a consideration of them in an *uncured* state."

The Brazilian sample of beans submitted to the Imperial Institute for analysis were reputed to be the "Para" variety and the examination gives them a distinctly different shape compared with Trinidad and Venezuelan beans. Recently it has been learned that the Brazilian beans from the Amazon region are not "Para" variety but "Angostura", but the sample obtained looked mixed—there were some beans resembling Trinidad beans in shape and others smaller, shorter and plumper. It is possible that in the Amazon basin the "Para" and "Angostura" varieties are "growing together".

One would assume from these reports that Brazilian beans would be more valuable than Trinidad and Venezuelan beans, although the reverse is the case, since they command only one-half to one-third the market value. This may be due to variety and aroma or curing. Venezuelan and Trinidad beans usually sell together and, until this year, the bulk of Venezuelan beans were cured in Trinidad. The firm who reported on the samples for the Imperial Institute may not have known this fact.

REVIEWS.

FOREST BIBLIOGRAPHY TO 31ST DECEMBER, 1933, PARTS I & II.

By the Department of Forestry, University of Oxford. *Hall the Printer, Ltd.*, Oxford, 1936 and 1937.

These are the first two parts of a Forest Bibliography, which it is the intention of the Forest Department of Oxford University to publish in approximately twelve parts; forestry literature in English, French and German, or in other languages provided it contains summaries in English, French and German, published up to the end of 1933 and contained in the library of the Department of Forestry, will be included in this Bibliography. Books and unpublished or confidential matters are not to be included.

A subject classification containing 16 main headings has been adopted, which has been collated with the decimal system of classification prepared by Dr. Flury and adopted by the International Union of Forest Research organisations.

Part I comprises: A. General Forestry (by countries); B. Silviculture: 1. General, 2. Seed and Seedlings. Part II comprises: B. Silviculture (continued): 3. Natural Reproduction, 4. Artificial Reproduction, 5. Tending, 6. Silvicultural Systems, 7. Notes on Trees. Included in Part I is a list of abbreviated titles and a table showing the subject classification which forms the basis of the Bibliography.

In the preface to Part I Professor Troup explains that the Bibliography was not originally intended for publication, otherwise it might have been prepared on different lines: at the outset the sole object of the work was to provide the staff and students with facilities for keeping in touch with the latest literature bearing on forestry, for which purpose a simple system of classification was devised. The decision to publish the work was the result of requests from various sources.

Whatever defects the work may possess as a result of these factors, it nevertheless represents the only serious attempt yet made to bring out a comprehensive classified list of forest literature in the languages already cited. It will, therefore, prove of very great value as a work of reference to all who are interested in the profession of Forestry.

R. L. B.

* * *

BULLETIN OF THE COLONIAL INSTITUTE OF AMSTERDAM, Vol. I, No. 1, 1937.

This new periodical has been issued with the twofold object of disseminating knowledge concerning the Netherlands Indies and related subjects among foreign readers who are not familiar with the Dutch language, and of familiarising the Dutch reading public with current problems in the Pacific. Owing to Dutch being little known abroad many of the problems affecting the Pacific area have been imperfectly understood by foreigners and it is chiefly to remedy this state of affairs that the Colonial Institute at Amsterdam and the Netherlands Pacific Institute have decided to publish this Bulletin. The publication will be mainly written in English although it is proposed also to have a small section in Dutch. The present issue includes, amongst others, articles on the Colonial Institute at Amsterdam; the Budget of the Netherland Indies; Malaria in the Netherland Indies; the Social Organisation in Borneo, Celebes and Moluccas; Air Transport in the Pacific Area and Notes on the Japanese Mandate Islands. As the range of subjects is a pretty wide one it is hoped that some attention will be paid in future numbers to colonial agricultural policy in the Dutch East Indies, and also to the fine work done by the Java and Sumatra agricultural research stations. Copies of the Bulletin and particulars regarding subscription rates may be obtained from the Editor, Koloniaal Instituut, 63, Mauritskade, Amsterdam, O. Holland.

G. G.

INVESTIGATION AND SELECTION IN THE OIL PALM.

By E. H. G. Smith, M.A., and F. W. Toovey, A.R.C.S., B.Sc., A.I.C.T.A.
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The Oil Palm (*Elaeis guineensis*, Jacq.) is indigenous to West Africa, and is distributed in a semi-wild state throughout Southern Nigeria. It has been exploited from time immemorial; and though largely uncultivated, the palm is by no means uncared for. During the last decade a movement of supreme importance to the Nigerian Oil Palm industry has begun; for, the Agricultural Department having successfully demonstrated the superiority of the planted and cultivated palm, as compared with the wild palm, the Nigerian peasant farmer has now begun to plant palms himself. The present total acreage (some 4,500 acres) of peasant owned plantation palms may not be impressive; but this development is now gaining momentum, and much more rapid progress seems certain to occur in future years. Among the factors which limit the rate of planting are the supply of selected seed, the ease with which oil palm seed can be germinated, and questions of land tenure (1). It has been found that prospective planters may be discouraged if they cannot be supplied with selected seedlings.

The Oil Palm.

The oil palm has been described by many writers, among whom may be mentioned Jagoe (12), and Beirnaert (4), who deal fully with floral morphology. The oil palm closely resembles the coconut palm, though perhaps in general appearance it is rather more robust. During the first two or three years after planting no stem is visible. Thereafter, as age increases, the stem gradually appears (Fig. 1), and is rather remarkable for the fact that the leaf bases adhere to it until the palm is in the neighbourhood of 20 years old. This gives the stem of a young palm the characteristic diamond pattern (Fig. 2), and the girth is appreciably increased compared with that of an old palm from which the leaf bases have fallen. The typical oil palm is made up of a tall straight stem surmounted by a crown of leaves. Normally, there arises in each leaf axil a single inflorescence which usually consists exclusively of male or female flowers (Figs. 3 and 4). Sometimes mixed or bisexual inflorescences are produced with both male and female flowers. Such mixed inflorescences are generally not as well developed as those with flowers of one sex only. An inflorescence does not, however, necessarily develop in the axil of every leaf, though according to Mason and Lewin (14) the spadix is probably never absent, and thus when not found it must have aborted. An instance has been recorded where more than one inflorescence had apparently been produced in the axil of a single leaf. This was observed in a very high yielding palm at Calabar, and three female spadices appeared to have arisen from one leaf. Leaves remain on the palm for about 12 to 18 months, and inflorescences reach anthesis some seven to 14 months after the leaves emerge. With very young palms these periods seem to be shorter than with older palms.

Oil Palm Fruit.

The oil palm fruit is a drupe. It consists of the following components (Fig. 6):—

(i) An external skin—exocarp.
(ii) Fleshy tissue (producing palm oil)—mesocarp.
(iii) Stony tissue (the shell)—endocarp.
(iv) The seed coat enclosing the kernel—testa.
(The kernel produces palm kernel oil.)

The skin varies in colour both at and before maturity, and some palms have fruits surrounded by a ring of sterile carpels. These characteristics are used to differentiate between the Nigerian oil palm types, as is described later. The mesocarp varies considerably in thickness, both with, and independently of, the shell and kernel. Certain palm fruits have a well marked ring of fibres, which varies in intensity, and which is situated in the mesocarp rather more than a third of the way through from the shell (18). This appears to be a characteristic of the so-called thin-shell (or soft) oil palm forms, and is at present used as a criterion in classification (Fig. 6). The "fibre ring" is usually well defined, but is not always completely separated from the shell at all points on the periphery. The individual fibres are usually fine in structure, and are distinct from the coarse fibres which may be seen closely surrounding the shell in thick-shell forms. The latter is called the "false fibre ring", and the true fibre ring can usually be distinguished readily from it. The shell also varies considerably in thickness, and again independently of, as well as with, the mesocarp and kernel. The criterion of "crackability" of the shell is used in classification; and the time honoured test of the Nigerian peasant—namely, whether or not a nut may be cracked with the teeth—is one of the tests for differentiating between thick- and thin-shell forms. This is obviously not entirely satisfactory as it naturally depends to some extent upon the human element—*i.e.*, "strength of jaw". But in practice this test has proved to be reasonably accurate, and in very few instances is there any real difficulty in deciding whether the nut can be cracked or not, as different observers seldom disagree. So far no more satisfactory rapid measure of shell thickness than this test of crackability has been devised. The term "nut" refers, of course, to the shell and its enclosed kernel after the mesocarp has been removed. The kernel also varies considerably in size.

Classification.

As a result of the past ten years' observations, the Nigerian oil palm classification has been subjected to some revision. A great many authors have classified the oil palm into varieties, and there seems to be little doubt but that the results of breeding will show some, and probably much, revision to be necessary. As a result of our experience with Nigerian palms we agree with the footnote (page 21) to Yampolsky's work (24), and consider that any present division of the oil palm into varieties is at the best tentative, and may even prove to be hopelessly inaccurate. One of us has already dealt with preliminary classification (18 and 19), and the present tentative and simple Nigerian oil palm classification has already been published (22). This classification is as follows :—

(i) Ordinary type—	(*a*) Thick-shell form.
	(*b*) Thin-shell form.
(ii) Mantled type—	(*a*) Thick-shell form.
	(*b*) Thin-shell form.
(iii) Greenfruited type	(*a*) Thick-shell form
	(*b*) Thin-shell form.
(iv) Mantled Green-	(*a*) Thick-shell form.
fruited type—	(*b*) Thin-shell form.

Palms are classified exclusively on fruit appearance, and are divided into *types* on external characters, and into *forms* on internal characters. Sub-forms are also recognised.

Division into Types.

The division into types appears to be clearly defined, and the above four are so far accepted as distinct. One or two instances have been observed of possible intermediates between the green and non-green characters, and the mantle also shows varying degrees of development. But in practice the classification on external appearance presents no difficulty, and distinctions appear to be real. All Nigerian types so far observed fit into the suggested classification, but it is, of course, possible that additional types do exist. The four types represent the possible combinations of what appear to be the mantled and non-mantled (Fig. 5), and greenfruited and non-greenfruited genetic characters :—

(i) Ordinary type—(non-mantled and non-greenfruited).

(ii) Mantled type—(mantled but non-greenfruited).

(iii) Greenfruited type—(non-mantled but greenfruited).

(iv) Mantled Greenfruited type — (both mantled and greenfruited).

The external appearance of the first three types was described by one of us in 1929 (E. H. G. S., 18), and the fourth represents a combination of the characters of the second and third. Of course these palm fruit characters have been previously recognised by Bücher and Fickendey (6), and other authors.

A brief description of the fruits may be of value :

(*i*) *Ordinary type.*—The fruits are glossy black after fertilization ; a reddish tinge appears as ripening progresses. When ripe the upper half is glossy dark red and the lower half light red in varying proportions. Internal fruits are usually only dark red at the apex.

(*ii*) *Mantled type.*—The fruits are surrounded by a ring of sterile carpels (usually six). The development of the mantle varies ; in some instances the fruits are almost entirely enclosed ; in others the mantle covers a half to two-thirds of the fruit, and in a few instances it is almost absent. Fruit colour is similar to that of the Ordinary type.

(*iii*) *Greenfruited type.*—After fertilization the fruits are pale green, and as growth proceeds the colour changes to a deep green. As maturity approaches, the green gradually disappears from the base upwards and a light red colour appears until only a green tip remains. When fully ripe the fruits are a light brick red.

(*iv*) *Mantled Greenfruited type.*—This is as the Greenfruited type except that the fruits are mantled.

Division into Forms.

The division into forms is based on the presence or absence of the fibre ring, and on the crackability of the nut, except that shell-less and kernel-less characters are noted. The terms "thick-shell" and "thin-shell" are arbitrary, and are used to describe two well recognised internal forms of oil palm fruit (Fig. 6). The typical thick-shell fruit has a thin mesocarp, a thick shell and a large kernel ; while the typical thin-shell fruit has a thick mesocarp, a thin shell and a small kernel. These two forms are often popularly spoken of as the "hard" (thick-shell) and "soft" (thin-shell) forms. In practice it is found that considerable variation occurs in the internal form of oil palm fruit ; the internal components appear to be controlled by a comparatively large number of genes, and to vary independently of each other. There seems to be a complete range from extreme thick-shell through thick-shell, intermediate, and thin-shell to shell-less and kernel-less fruits. The principal argument that can be urged in favour of the present division is that the majority of fruits appear to fall into two groups, the thick- and thin-shell forms. A few examples of variation may be quoted. In the thick-shell form, fruits are found with a mesocarp thickness above average ; with shell thickness below average but not reduced enough to fall into the thin-shell form ; and with shells exceptionally thick. In the thin-shell form fruits occur in which mesocarp thickness is reduced below average ; and other fruits have exceptionally large kernels for this form.

The present division into the two main forms is entirely an arbitrary one. Thin-shell fruits are those which satisfy one or more of the following tests :—

(i) A fibre ring is present, or
(ii) the nut can be cracked with the teeth, or
(iii) the fruit is shell-less or kernel-less.

All other fruits are classified as thick-shell.

The two main forms have been divided into the following sub-form, though the characters of the sub-forms are not yet absolutely defined :—

(*a*) *Thick-shell form.*
(i) Very thick-shell (exceptional shell thickness).
(ii) Thick-shell (fruits of normal shell thickness).
(iii) Intermediate thick-shell (shell just too thick to be cracked with the teeth).

(*b*) *Thin-shell form.*
(i) Intermediate thin-shell (fibre ring present but nut cannot be cracked with the teeth ; it almost invariably just cannot be so cracked if the fibre ring is present).
(ii) Thin-shell (fibre ring present and nut can be cracked with the teeth).
(iii) Shell-less (shell absent but kernel present, the latter invariably very small).
(iv) Kernel-less (shell and kernel absent).

The writers do not wish to suggest that the above represents their final view on the correct classification of internal characters, but so far there appears to be no better alternative, and the above scheme has been proved by experience to be reasonably workable. The study of this question has been handicapped by the limited amount of fruit available other than of the thick-shell form, but the breeding work in progress is steadily producing more of the desired material. Progress is so slow, however, that it is impossible to await further results before attempting preliminary classification. In fact, with oil palm work, anything in the nature of complete results can hardly be anticipated until several generations have been worked through. Workers in the Dutch East Indies also recognise that this question of " varietal " classification in the oil palm is a difficult one until more is known of the lines on which fruit form is inherited (17). It should perhaps be mentioned that internal form has been found to vary independently of type, and that it appears that any possible internal form may occur with any type.

Inheritance.

It would be premature to attempt any very definite generalization on the inheritance of oil palm fruit characters. A great many of the seedlings produced by the first series of controlled pollinations have yet to fruit. Initially, it was thought that inheritance of fruit characters might perhaps be more simple than it now appears to be, but it was very soon discovered that the original suggestions advanced (18) did not hold good. Preliminary results of initial breeding experiments were published (20) in 1934 and the figures can now be brought up to date (parenthesised figures are percentages) :—

(i) Thick-shell palms, self-fertilized, have given :—
Thick-shell—927 ....(95.5 per cent.)
Thin-shell—44 ....(4.5 per cent.)
(ii) Thin-shell palms, self-fertilized, have given :—
Thick-shell—389 ....(43.4 per cent.)
Thin-shell—508 ....(56.6 per cent.)
(iii) Greenfruited palms, self-fertilized, have given :—
Greenfruited—575 ....(67.8 per cent.)
Non-greenfruited—273 ....(32.2 per cent.)

Figures for naturally pollinated palms taken from the 1934 note quoted above are included for comparison :—

(i) Thick-shell palms, naturally pollinated, have given :—
Thick-shell—508 ....(92.5 per cent.)
Thin-shell—40 ....(7.5 per cent.)
(ii) Thin-shell palms, naturally pollinated, have given :—
Thick-shell—304 ....(72.0 per cent.)
Thin-shell—119 ....(28.0 per cent.)
(iii) Greenfruited palms, naturally pollinated, have given :—
Greenfruited—82 ....(46.0 per cent.)
Non-greenfruited—96 ....(54.0 per cent.)

It appears that the range from very thick-shell to kernel-less is controlled by a number of genes, with some degree of dominance of the genes supplying the thick-shell attributes. With external characters (the Ordinary and Greenfruited types) fewer genes appear to be involved, and dominance appears to lie with the Ordinary type, though it is not suggested that this is complete. Insufficient results are as yet available for any conclusions to be drawn which involve the Mantled and Mantled Greenfruited types. As a generalization, from the above figures, it may be said that in the first generation of self-fertilized palms there has been an increase in the proportion of palms showing greenfruited and thin-shell characters, and some diminution in the number of thin-shell palms thrown from thick-shell seed.

As was mentioned when selection was first described (18), it is not possible to guarantee the absolute reliability of all fertilizations, and some pollinations have produced a few results which may be due either to the genetic composition of the parents, or to the incursion of foreign pollen. For instance the Mantled Greenfruited type first appeared in experimental plots in the progeny of a Mantled self-fertilization, and such palms have also appeared in pollinations of the Greenfruited type.

The possibility of the production of unexpected progeny was anticipated when work commenced, and detailed records have been kept of progenies according to the particular fertilization from which these have arisen. Each female

inflorescence subjected to controlled pollination (termed a "bunch") is given a bunch number, and all seedlings are recorded by bunch as well as by parental numbers. Thus where a palm exhibits unexpected fruit characters it can be compared with other palms that resulted from the same fertilization. Actually, the number of unexpected progeny so far recorded is not great. Out of 1,030 self-fertilized progenies of the Ordinary type, 46 palms exhibiting Mantled or Greenfruited characteristics have appeared, *i.e.*, about 4.5 per cent. While out of 848 self-fertilized progeny of the Greenfruited type, 14 palms have been produced with the Mantled, or with the Mantled and Greenfruited, character, *i.e.*, approximately 1.7 per cent. Whether these results are due to genetic factors or to foreign pollen cannot yet be determined.

In the above figures the results of all fertilizations so far available have been given with the exception of the progeny of one Greenfruited bunch. This bunch has only a small progeny, but it has thrown exclusively non-greenfruited palms. One or two other pollinations are also to some extent suspect, but have been included. Much more material is required before it will be profitable to analyse results according to bunch numbers, and to investigate suspected fertilizations.

High Percentages of Thin-Shell Palms.

It should be noted that nothing like the proportion of thin-shell to thick-shell palms raised from naturally pollinated thin-shell seed, has been observed in Nigeria as is reported for the Njala plot of Nigerian palms in Sierra Leone by Deighton (7 and 8). This palm seed was obtained from the Calabar region of Nigeria in 1918, and as is not unnatural for that period no record has been found of the actual mother palms. According to Deighton's figures, approximately 50 per cent. of the progeny of this seed has turned out to consist of thin-shell palms. The comparable Nigerian percentages observed are about 28.0 per cent. of thin-shell progeny for natural pollination and about 56.6 per cent. of thin-shell progeny with self-fertilization. A possible explanation of the variance from Nigerian results is that the seed came from parent palms growing where the thin-shell form was present in an unusually high proportion, and that the flowers were thus largely fertilized by thin-shell pollen. Natural palm groves containing a high percentage of thin-shell palms are known to exist in Nigeria, though, taking the country as a whole the thick-shell forms very largely predominate.

Variation in Inheritance with Individual Palms.

There is quite naturally a very appreciable variation in inheritance between individual palms. The following figures (Table I) for the self-fertilized progeny of some ordinary thin-shell parents are of interest, and suggest that these palms vary in genetic composition.

Table I.

Selected Palm Number.	Progeny.				
			Analysis of Thin-shell forms into sub-forms.		
	Thick-shell Form.	Thin-shell Form.	Intermediate Thin-shell.	Thin-shell	Shell-less and Kernel-less.
244	22	36	19	17	—
339	23	57	6	49	2
340	48	74	49	15	10
387	82	88	29	58	1
416	30	14	3	11	—

Unfortunately it has not yet been possible to classify the parent Calabar palms into the more recently devised sub-forms. But of the above selections, No. 340 approaches the intermediate thin-shell sub-form, and, as appears in the above table, its progeny contains many intermediate thin-shell palms. Somewhat surprisingly, however, this selection has thrown a comparatively large number of shell-less and kernel-less palms. It is possible, of course, that palms classified into one of the two latter sub-forms when young, may produce fruits with more shell and kernel as age increases. But palm No. 340 is not an isolated instance, as some greenfruited thin-shell palms have produced progenies with similar distribution over the thin-shell sub-forms. Palm No. 339 appears likely to be a valuable selection if further progeny follow the above proportions, and fortunately it is a promising selection from several other aspects. The figures for palm No. 416 are surprising, as this palm possesses the highest mesocarp percentage of those included in the above table. To conclude this subject, the writers cannot do better than quote Schmole (*loc. cit.*).

> "At present we are not in possession of sufficient particulars to determine along which line the fruit form is inherited. It is however certain that with self- as well as cross-pollination, palms with *tenera* fruit form can produce an off-spring with *pisifera*, *tenera* and *dura* as well as *macrocarya* fruit forms."

It is believed that the above terms correspond to the Nigerian classification—*i.e.*, *tenera* = thin-shell, *pisifera* = shell-less and/or kernel-less, *dura* = thick-shell, or possibly thick-shell with thick mesocarp as it is used for the Sumatran Deli type, and *macrocarya* = very thick-shell.

Selection.

Selection with the oil palm is inevitably slow. Palms do not approach full bearing until from 10 to 12 years after planting out in the field; thus, if proper attention is paid to the yield factor, a single generation in oil palm selection may occupy

PLATE I

FIG. 1.—Young palm showing early stem formation.

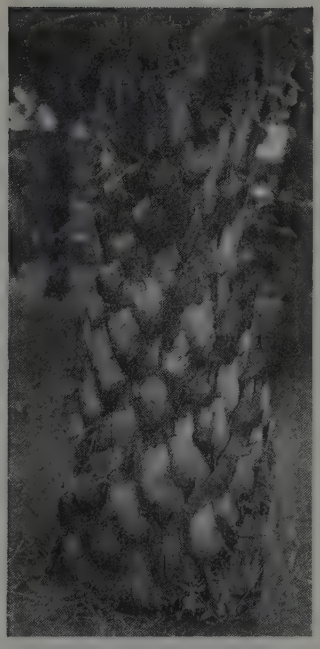

FIG. 2.—Older palm showing characteristic diamond pattern on stem.

FIG. 3.—Male inflorescence.

FIG. 4.—Female inflorescence.

PLATE II

OIL PALM FRUITS.

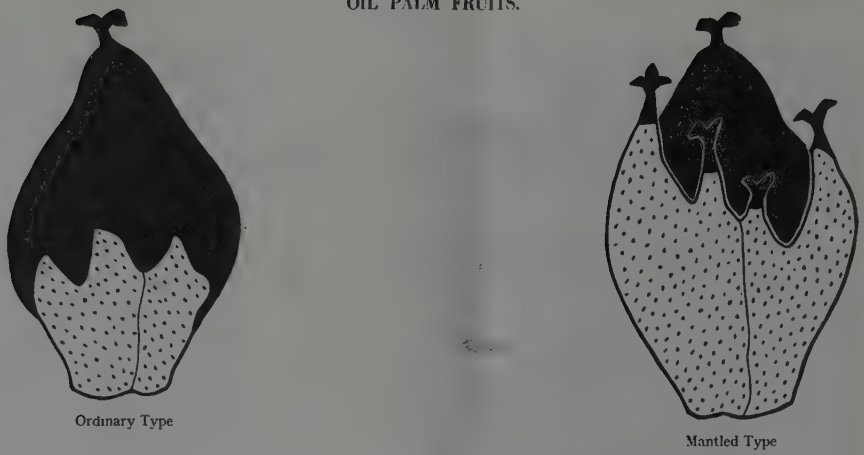

Fig. 5.—Showing external appearance of Single Fruits of ordinary and Mantled Oil Palm Types.

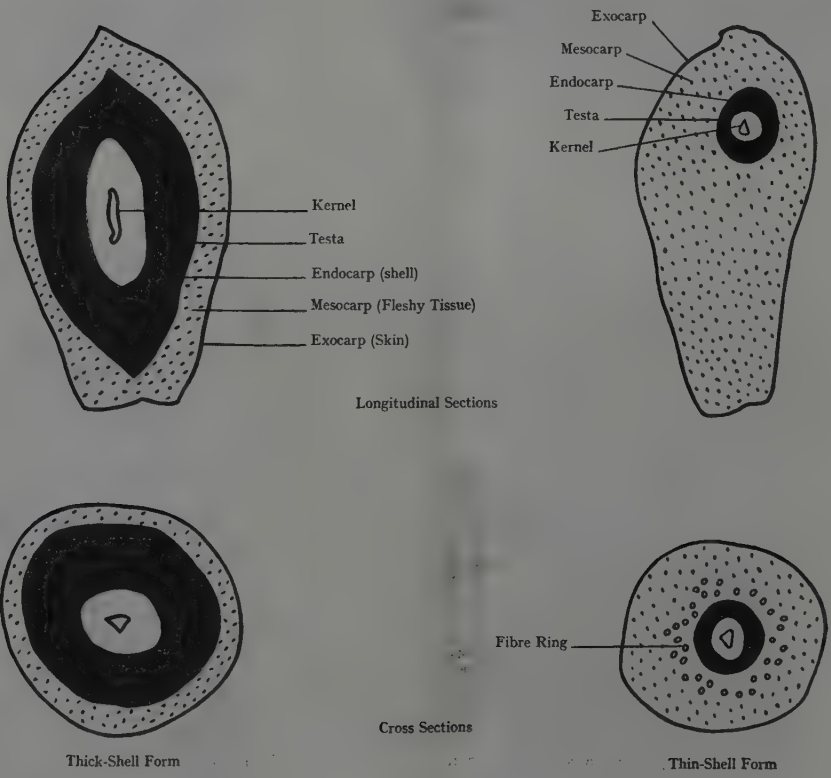

Fig. 6. Sectional Drawings of Typical Thick and Thin-Shell Fruits.

Note (i) Mesocarp produces commercial palm oil.
(ii) Fibre ring in cross section of thin-shell Form.

FIG. 7.—Oil palm analysis. *Left to right*:
(*a*) sample of fruit prepared for analysis,
(*b*) nuts after washing,
(*c*) fibre after washing.

FIG. 8.—Oil palm seed germination trays.

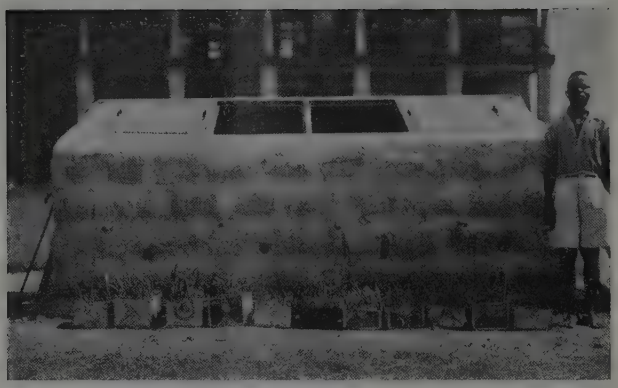

FIG. 9.—Oil palm seed germinator.
Note: (i) trays removed to show seedlings,
(ii) muslin covers to glass frames, used in hot dry weather only,
(iii) two centre glass frames removed.

FIG. 10.—Nursery bed of young palm seedlings transplanted from germinator in background.

any period up to 15 years. Serious selection began in 1928, following a number of years of yield recording of the Calabar palms (18). Brief notes of subsequent progress have also been published (20 and 21).

Work in Nigeria has been handicapped by lack of sufficiently diverse material in areas where selection could be undertaken. Palms planted prior to 1930 consist very largely of the Ordinary thick-shell form; and no examples of the Mantled Greenfruited type existed in any accessible area until such palms appeared by chance in the experimental plots.

The Calabar plantation palms provided the only likely selection area available for some years. Self-fertilized progenies of Calabar selections were planted out at the experimental farms during the years 1930-35. At the moment, including plots of all descriptions, some 77 acres are planted up with such progenies, and the total number of individual first generation palms of the Calabar selections is in the neighbourhood of 4,500. Compared with the scale on which work has proceeded at Yangambi (16) in the Congo this is a relatively small population.

This acreage is divided between four experimental farms, one of which, at Benin, occupies the position of first importance. Although the Nigerian selection areas are at the moment comparatively small, there is the advantage that the progeny of each selection is already under trial in more than one locality. Further work with Calabar material is now being deferred until selection of the next generation can be undertaken.

It has been fully realised that a weakness in Nigerian oil palm selection has been that it was initially confined to a very narrow field—the comparatively small population available at Calabar—and efforts have been directed towards widening the basis of selection. Individual yield recording at Aba, in Owerri Province, carried out by Mr. J. W. Wallace, Agricultural Officer, has led to the discovery of a second field for selection, and at the present time controlled pollinations are being carried out there. The Aba palms appear to be especially promising as regards yield. Fortunately, a third selection area appears to have been discovered, by the Agricultural Officers in Onitsha Province, but the potentialities of the latter area are not yet fully determined. Attention has also been called to the "Lisombe" palm through work on the plantations of the United Africa Company. The true Lisombe is apparently an excellent variety of the Ordinary thin-shell palm. A few small areas of Deli palms, obtained from Sumatra, are also under trial, but the latter variety does not promise to be outstanding in Nigeria.

The next decade is likely to produce appreciable development in oil palm selection. The initial progenies of the Calabar selections will become old enough for further selection in a few years' time—in itself a formidable undertaking—and selections from other areas will become available for planting in increasing numbers. To provide for this expansion of work, further land is being sought for experimental plantings. An unfortunate effect of the recent depression has been that oil palm selection has been limited by financial considerations. The rate of development has been reduced by lack of land, staff, and money; but these restrictions seem now likely to be very largely overcome. At the present time it is not possible to add very much to what has been already published regarding selection in Nigeria, as all plots of selected palms are still very young, and appreciable results from the initial selection programme are yet to be obtained.

Seed Multiplication.

Attention has been paid to multiplication plots for the production of improved oil palm seed for the Nigerian farmer (23). Many years must elapse before pure oil palm strains can be produced, but meanwhile seed can be taken from palms grown from self-fertilized seed of parent trees that have passed an initial selection test. But there are obvious objections to the use of seed from experimental plots, as these are certain to contain off-type and poor yielding palms that cannot be removed on account of experimental considerations. Thus special isolated multiplication plots are necessary from which all off-type and poor yielding palms can be rogued out. The value of such plots has been recognised in the Congo (3); and, whereas special seed multiplication plots are desirable if seed of thick-shell form is required, these are doubly necessary for the production of improved seed of the thin-shell forms.

While the thick-shell forms very largely breed true to the parental form, whether subject to self- or to cross-pollination, thin-shell forms appear to give in the neighbourhood of 57 per cent. of thin-shell progeny when self-fertilized; but (excepting Sierra Leone results) only some 28 per cent. of thin-shell progeny when cross-pollinated. The actual proportion with natural pollination would appear likely to depend on the surrounding palm population. In order to provide the highest possible proportion of thin-shell palms for the Nigerian peasants' plantations, thin-shell palms must be artificially self-fertilized, or be permitted to cross among each other. The latter alternative, provided for in the isolated multiplication plot, is the only practicable procedure for a bulk seed supply scheme.

In 1935, two isolated thin-shell multiplication plots were established, one of ten acres for the Ordinary thin-shell form, at Benin, and one of five acres for the Greenfruited thin-shell form, at Onitsha. A further ten acre plot for the Ordinary thin-shell form is to be added in 1937. On account of segregation of the Ordinary and Greenfruited types, present figures suggest that the expectation of greenfruited thin-shell palms, in the progeny arising from the self-fertilization of such parent palms, is only about 39 per cent.

When the seed multiplication plots come into bearing all off-type palms will be removed, and the vacancies so created will be filled. It is envisaged that this procedure will be repeated as often as practicable. Within each of these multiplication plots only one oil palm form will be maintained, and seed from palms that have cross-pollinated only with palms of the same form will be available for the peasant plantations. In later years it will be possible to improve the seed supply a degree further by the removal of all poor yielders. Such plots represent, in effect, a form of mass selection for the production of improved oil palm seed.

As with oil palm experiments, multiplication plots have only been established on a reduced scale, and on account of similar considerations. Provision for an appreciable extension of seed multiplication areas is now under consideration.

Comparative Value of Thick- and Thin-Shell Forms.

Superficially, the thin-shell forms may appear perhaps to be more attractive to the farmer than the thick-shell forms, as fruit of the former produces more oil. But in the yield figures so far available, it appears that ordinary thick-shell palms give in the neighbourhood of at least a 25 per cent. increased yield of fruit per acre compared with that of ordinary thin-shell palms. This yield difference has already been discussed by one of us (19), and, if proved to be generally true, is a very important factor in assessing the merits of the two forms. Results of oil extraction work also show that to obtain a proper return from thin-shell fruit the peasant farmer must use an oil palm hand press (2), otherwise thick-shell palms appear likely to pay him better. Incidentally, extension work with palm presses is an important feature of the work of the Nigerian Agricultural Department. It is of interest to observe that the latest yield data available from Nigeria, as yet unpublished, and Sierra Leone (8) support the figures previously published, and suggest that this yield difference is real. The above comparison is, however, only true for palms of the Ordinary type as no similar data are yet available for the other types. It is also necessary to say that many more yield figures are required before the above difference can be definitely asserted, and that the effect of selection for yield with thick- and thin-shell forms is still to be determined.

Oil Palm Fruit Analysis.

Another essential need in oil palm selection is to obtain accurate information on the composition of the fruit. The classification of fruits into types and forms, according to the scheme already outlined, gives a rough idea of the amount of mesocarp present, but it does not indicate the relative value of fruits of the same form. Accordingly, a method of "fruit analysis" has been devised to determine the percentage of mesocarp, fibre, shell and kernel present in a sample of fruit (Fig. 7). The method used has already been described (18). It is essentially a field method, but up to the present it has given very satisfactory results, and the degree of accuracy obtained does not appear to be far removed from that obtained by more elaborate means. Moreover, it has the very great merit that a large and representative sample of fruit can be rapidly analysed by relatively unskilled African assistants. In Table II are given specimen results obtained by the use of this method for various fruit types.

Table II.

Fruit Form.	Percentage Composition of Fruit.					
	Mesocarp.	Fibre.	Shell.	Kernel.	"Loss".	Total
Nigerian Mantled thin-shell ...	77.0	5.9	9.0	7.0	1.2	100.1
Nigerian Ordinary thin-shell ...	70.3	3.5	16.8	7.8	1.6	100.0
Nigerian Greenfruited thin-shell ...	66.0	2.7	14.5	15.2	1.6	100.0
Sumatran Deli	57.4	3.1	26.6	9.4	3.5	100.0
Nigerian Mantled thick-shell ...	56.6	3.9	28.5	9.8	1.2	100.0
Nigerian Ordinary thick-shell ...	42.2	2.3	39.5	13.3	2.7	100.0
Nigerian Greenfruited thick-shell ...	41.0	2.0	41.4	14.5	1.2	100.1

Note 1.—In column 3 the figures given are for the fibre contained in the mesocarp, and in column 2 the figures given represent the mesocarp and exocarp less the fibre. Hence the figures in columns 2 and 3 should be added together to give the "percentage mesocarp" as ordinarily understood.

Note 2.—The percentage "loss" given in column 5 represents the unavoidable error due to the drying of the nuts which is necessary before they may be cracked to extract the kernels.

The results given in this table were actual figures obtained for individual palms. They are not intended to indicate the relative fruit composition of the palm forms cited, although they do, as a matter of fact, closely approximate to the average values which have so far been obtained for these forms. Even from the few results given it is clear that there is a wide range of fruit form, based on percentage composition among Nigerian oil palms, and the importance of this for selection purposes is obvious. The value of oil palm fruit analysis for providing data as to the relative composition of fruit of similar form is also clear. The Deli palms, raised at Ibadan from Sumatran seed, show remarkably little variation in fruit composition, although a considerable number of analyses on fruit from these palms have already been done.

The Method of Artificial Pollination.

The method used for the production of seed from selected trees by artificial pollination presents some modification of that originally devised by Hill and Mason (11), and appears to be similar to that used in Malaya and the Congo. Since the revised method was first described (18), further minor modifications have been introduced. The bag used for enclosing the male and female inflorescences is now provided with a fixed celluloid window. Pollen is stored in small test tubes plugged with cotton wool instead of envelopes. Bagging is carried out somewhat earlier than is indicated in the reference cited; in the case of the male inflorescence the bag is put on just as the "fingers" loosen, while in the case of the female inflorescence bagging is done just as the individual flowers begin to expand. One further modification which it is hoped to introduce shortly, is the separation of the pollen and anthers by means of an 80 mesh sieve instead of by hand.

Observations on Growth and Flowering.

An important line of work, which is being undertaken concurrently with the breeding programme, is the investigation of the growth and flowering characteristics of the oil palm. The present "oil palm observations", as they are called, represent a development of the original investigation undertaken by Mason and Lewin (14). For this work a number of palms of varying age and fruit form have been selected for observation at three stations in Nigeria (Ibadan, Benin and Umuahia). On these palms, records are made of the following points:—

(i) Date of opening of each new leaf.

(ii) Date of opening of each inflorescence, and the sex of the inflorescence.

(iii) Where the inflorescence is female, the date of maturing of the ripe bunch, the weight of the bunch, and the weight and numbers of fertile and infertile fruits which it contains.

These observations have now been in progress for a number of years, but it has not yet been possible to analyse the mass of data which has accumulated. It is hoped that the information obtained will throw light on the relation of growth in the oil palm to climatic factors, on the periodicity of flowering, on the relation of the sexes of the inflorescences, and on fruit setting.

Germination of Oil Palm Seed.

The poor germination of oil palm seed has proved a serious problem, and experiments to improve germination have recently been undertaken. As the work has only been in progress for a short time it is not yet possible to draw any very definite conclusions; nevertheless there are certain indications arising from the work which seem worthy of record at this stage.

Published reports from other countries (5, 10, 13 and 15), and local experience, suggest that some form of heat treatment improves the germination of fresh seed. Accordingly, the experiments which have been undertaken have been directed mainly to the investigation of the effect of heat on germination.

Most of the experiments in which heat was applied as a *pre-treatment* of the seed have shown little effect of such treatment on germination. Hot water treatment of nuts or kernels, using a wide range of temperatures and times of treatment, has failed to improve germination. Efforts made to facilitate the uptake of water by the kernels, such as by cracking the shells, planting kernels alone, and removing part of the testa, also had little effect on germination, even when various heat pre-treatments were applied.

The greatest success so far has been obtained by germinating the seed under *constantly* warm conditions. One of the causes of poor germination in the past has been the destruction of seed in the seedbeds by ants. Shallow germinating trays made of galvanized iron and raised above the ground (introduced by Mr. J. W. Wallace, Agricultural Officer), have proved effective in reducing the ravages of ants to negligible proportions (Fig. 8). The application of heat to these trays has been tried at various stations in Nigeria. The heat is applied by lighting small wood fires below the trays at night. The space below the trays is walled in by corrugated iron in order to keep in the heat as much as possible. By this means the germinating medium in the tray (usually river sand overlying earth) is kept warm during the night when the temperature is liable to drop considerably, especially during the rains. Results obtained at Benin, which have been kindly supplied by Mr. J. L. B. Kincaid, Agricultural Officer, have proved to be very variable, but the average germinations obtained are much better than are obtained when the trays are not heated. An average germination of just over 25 per cent. in 6 months has been obtained for a wide range of fruit types but in some instances germinations up to 60 per cent. in the same period have been obtained.

At Ibadan, artificial "germinators" have been used for germinating seed under constantly warm conditions (Figs. 9 and 10). The type of germinator used has been adapted from an artificial propagator used in Kenya for the vegetative propagation of coffee (9). Briefly, it consists of two chambers; the upper contains the trays in which the seed is sown in sand, and the lower takes the fire for heating the germinator. An average temperature of 35°C is aimed at inside the upper chamber, but in practice the temperature varies from 30°C to 40°C. To achieve this, firing is done as often as necessary during the night and sometimes during cold mornings in the rains. The sand in the germinating trays is kept moist, and the atmosphere inside the upper compartment is always saturated with moisture. Thus the seeds are germinated under constantly warm and humid conditions. Ants are excluded from the germinator by means of an antiformica around the base. Germinators of this type have given very encouraging results. Percentage germinations of over 60 per cent. in six months have been obtained in some instances, but again the results have been very variable, and the average germination for a wide range of fruit types has been about 25 per cent. in six months. This average is considerably better than that obtained in ordinary seed beds or in unheated raised trays. The improvement in germination obtained by means of germinators is illustrated by the results set out in Table III. For comparison, the germination percentages of similar seed given certain pre-treatments and that of untreated seed are tabulated. It should be noted that seed for all treatments was selfed seed taken at one harvest from one tree only so that it should have been as uniform as possible.

Table III.

Treatment.	Percentage Germination.	
	After 4 months.	After 6 months.
1. Sown in Germinator	42	61
2. Sown in unheated raised trays		
(*a*) Seed kept at 43°C for 3 weeks	1	2
(*b*) Seed kept at 43°C in water for 3 weeks	1	1
(*c*) Control	1	1

A comparison of the germinations obtained with heated trays and germinators has shown that there is little difference between the results obtained by either method. Both treatments give better germination than is obtained with seed planted by ordinary methods even when the attacks of ants are avoided. It seems clear therefore that a more-or-less constantly high temperature improves germination. While further work is necessary before conclusions can be drawn, and while heated trays give very satisfactory results, there is some indication that germinators produce rather healthier seedlings.

For comparison it may be of interest to quote the results obtained at the United Africa Company's plantation at N'dian in the Cameroons; these results are taken from an unpublished report on a visit to N'dian by our colleague Mr. West. At N'dian 50 per cent. of the total germination occurs, generally speaking, within the 12th to 20th weeks from sowing, and germination is considered complete by the end of the 52nd week. Total germination figures range from 50 to 60 per cent. for Lisombe seed, 70 to 90 per cent. for Deli seed and 20 to 30 per cent. for Calabar (Nigerian) seed.

We are also indebted to the United Africa Company for suggesting the possibility of using smoke-house treatment of seed as an aid to improved germination. On their plantations good germination has been obtained by subjecting seed to a preliminary treatment in the smoke-house of a rubber factory. At Ibadan, a trial of this method has recently been undertaken, using a small artificial smoke-house. So far excellent results have been obtained with a large sample of stale seed (60 per cent. in five months). The method has not however been given a sufficient trial to form a definite estimate of its value. One disadvantage of the method seems to be the difficulty of preventing the seedlings dying off after they have germinated.

One point which has come out of these preliminary experiments on oil palm seed germination is the extraordinary variability of the results. For example, self-fertilized seed from a selected palm at Aba (No.UZ864) has given such consistently high germination figures that, with each new batch of seed sown in the germinator, at least 60 per cent. germination within six months is now expected. This variability has also been noted by Maas (13). No other interpretation of this seems possible than that there is a variation in germination power between seeds from different palms, a suggestion which has been put forward by Beirnaert (5). If this explanation is correct, it undoubtedly accounts for the many anomalous results reported in the literature on oil palm seed germination. It shows, moreover, the importance of using uniform seed for germination experiments; the seed should either be all taken from one tree at one harvest, or the samples subjected to the various treatments should consist of equal numbers of seed from the same trees. It is also clear that at least a proportion of Nigerian seed has only a feeble germination power.

At this stage, little more can be said on the subject of germination. As mentioned above, the work has not proceeded far enough to give any very definite conclusions. Germinating seed under constantly warm conditions appears to give good results however.

ACKNOWLEDGMENTS.

It is difficult to give adequate acknowledgment of the assistance received with the oil palm work described in this paper. To a greater or lesser extent nearly every Officer of the Department in the Southern provinces has helped in some way or another, and it would be impossible to attempt to mention all individual names. We also wish to acknowledge the work of the African assistant staff, among whom Mr. D. L. Cole is responsible for the drawings in Plate 2. But in particular, mention must be made of the helpful criticism of our colleagues Messrs. O. J. Voelcker and J. West. The latter has also very kindly undertaken the photographic work for this paper. We are indebted to Mr. J. W. Wallace for his work at Aba on oil palm selection, and to Mr. J. L. B. Kincaid for kindly supplying germination figures. In conclusion, we can only hope that others who have given such generous assistance will accept the general acknowledgment already made.

References.

1. "Address by His Excellency the Governor to the Legislative Council".—*Supplement to Extraordinary Nigeria Gazette* No. 18 of 22nd March, p. 10, 1937.
2. Barnes, A. C.—"An Improved Process for the Extraction of Palm-Oil by Natives". *Fifth Annual Bulletin of the Agricultural Department,* Nigeria. pp. 33-49, 1926.
3. Beirnaert, A.—"La Sélection du Palmier a Huile". *Bulletin Agricole du Congo Belge.,* XXIV, No. 4, pp. 418-458. 1933.
4. Beirnaert, A.—"Introduction à la Biologie du Palmier Elaeis". *Revue de Botanique Appliquée et d' Agriculture Tropicale.* 172, pp. 1091-1108, 1935.
5. Beirnaert, A.—"Germination des Graines d'Elaeis. Essais entrepris a Yangambi". *Publications de l' Institut Nationale pour l'Etude Agronomique du Congo Belge. Série Technique.* No. 4, 33 pp., 1936.
6. Bücher, H. and Fickendey, E.—"Die Olpalme." Berlin. 1919.
7. Deighton, F. C.—"Report on the Nigerian Oil-Palm Plantation at Njala, Sierra Leone". *Bulletin 7, Agricultural Department,* Sierra Leone. 1929.
8. Deighton, F. C.—"Njala Oil-Palm Plots". *Annual Report, Department of Agriculture,* Sierra Leone, Appendix IV, 1935.
9. Gillett, S.—"Vegetative Propagation of Coffee" *East African Agricultural Journal,* I, i, pp. 76-83, 1935.
10. Heinrichs, Th.—"Keimversuche mit Olpalmensaaten". *Der Tropenpflanzer.* No. 12. pp. 513-521, 1933.
11. Hill, A. G. G. and Mason, T. G.—"The Pollination of the Oil Palm (*Elaeis guineensis*)". *Fourth Annual Bulletin of the Agricultural Department,* Nigeria. pp. 120-121, 1925.
12. Jagoe, R. B.—"Notes on the Oil Palm in Malaya, with Special Reference to Floral Morphology. *Malayan Agricultural Journal.* XXII. pp. 541-549, 1934.
13. Maas, J. G. J. A.—"Planting of Oil Palms". Chapter 3 in "*Investigations on Oil Palms*". By Rutgers *et al.* Medan. 1922.
14. Mason, T. G. and Lewin, C. J.—"Growth and Correlation in the Oil Palm (*Elaeis guineensis*)". *Annals of Applied Biology.* XII. No. 4. pp. 411-421, 1925.
15. Milsum, J. N.—"Hastening the Germination of Oil Palm Seeds". *Malayan Agricultural Journal* XV, No. 3, pp. 82-84, 1927.
16. Rapport Annuel pour l'Exercice, 1935. *Institut National pour l'Etude Agronomique du Congo Belge. Bulletin Agricole du Congo Belge* XXVII, No. 3, pp. 379-441, 1936.
17. Schmole, J. F.—"The Selection of Oil Palms. (*Elaeis guineensis,* Jacq.)" *Agricultural Papers. 4th Pacific Science Congress.* Batavia, pp. 185-190, 1929.
18. Smith, E. H. G.—"The Oil Palm (*Elaeis guineensis*) at Calabar". *Eighth Annual Bulletin of the Agricultural Department,* Nigeria. pp. 5-42, 1929.
19. Smith, E. H. G.—"Further Yields from the Calabar Plantation Oil Palms". *Tenth Annual Bulletin of the Agricultural Department,* Nigeria. pp. 1-18, 1933.
20. Smith, E. H. G.—"A Note on Recent Research on Empire Products." *Bulletin of the Imperial Institute,* London, XXXII, No. 3, pp. 454-457, 1934.
21. Smith, E. H. G.—*ibid.* XXXIII. No. 1, pp. 73-75, 1935.
22. Smith, E. H. G.—*ibid.* XXXIII. No. 3, pp. 371-372, 1935.
23. Smith, E. H. G.—*ibid.* XXXIV. No. 2, pp. 266-267, 1936.
24. Yampolsky, C.—"Varieties in the Oil Palm (*Elaeis guineensis,* Jacq.)". Chapter 2 in "*Investigation on Oil Palms*" by Rutgers *et al.* Medan 1922.

MUTATION IN TOBACCO VIRUS.

Mutations in viruses are the subject of a paper by Dr. H. H. McKinney (*J. Hered.*, 28, No. 2), who cites experimental work, especially with mosaics of tobacco. While these viruses tend to remain true to type over long periods, yet they give rise in local zones of the infected plant to aberrant viruses which when isolated induce distinct symptoms. Some of these aberrant viruses in turn give rise to others. This is interpreted as a mutational phenomenon. Such mutants differ in the changes they produce in the chlorophyll mechanism of the leaf, some producing no disturbance, others a slight disturbance (light green mottling), others a yellowish-green, yellow or even almost white colour. Temperature has an important effect on these disturbances. Nearly a hundred mutants have been isolated from the common mosaic, but the number of distinct types is uncertain. Sub-mutants are also produced, the whole system of types tending to show certain relationships. The generation of these bodies is believed to be different from that of an enzyme from its precursor. The primary virus and its mutants are regarded as a series of closely related compounds which function essentially as genes.—(*Nature,* Vol. CXL, No. 3531, p. 33, 1937.)

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

The Sugar Industry.

Owing to a less favourable growing season, sugar production in the eastern West Indies in 1938 will be less than in 1937. In St. Kitts, where dry conditions have been most severe, the 1938 crop is estimated at about 28,000 tons or nearly 20 per cent. less than last year. In Antigua, another good crop is anticipated, although total production will not reach the record figure of 34,000 tons in 1937. In St. Lucia, the drier conditions have been favourable for good growth in the leeward valleys and total production is estimated at 8,400 tons or a few hundred tons in excess of last year's figure. In Trinidad and Barbados, production is estimated at ten to 15 per cent. less than in 1937.

Restriction of syrup or "fancy molasses" Production.

A meeting between representatives of the syrup producers in St. Vincent and St. Lucia and representatives of the Barbados Export Molasses Association was held in Barbados on 11th November, 1937, when agreement was reached that exports of syrup from St. Vincent and St. Lucia should be restricted as follows:—

	1938.	1939.	1940.
St. Vincent (barrels)	6,000	7,000	8,000
St. Lucia ,,	1,000	1,500	2,000

Legislation will be enacted in St. Vincent and St. Lucia to restrict exports accordingly. Exports from Barbados are already controlled by legislation.

* * *

The Cotton Industry.

West Indian Sea Island Cotton Association.

A summary of the proceedings of the second ordinary general meeting of West Indian Sea Island Cotton Association (Incorporated) was reproduced in the last issue of this Journal. The meeting reviewed the work accomplished by Mr. F. A. Squire, Entomologist, Cotton Pest Investigation, Windward and Leeward Islands, during the first year of his investigations of the problem of cotton pest control and made the following recommendations:—

(*i*) *Spraying as a measure of control of the cotton leaf defoliator (Alabama argillacea).*

The meeting recommended that the Agricultural Departments of the several cotton growing Islands institute as soon as possible a series of experiments in their respective Islands to determine the relative merits and costs of the present system of dusting with a lime—Paris Green mixture and a system of spraying with lead arsenate as suggested by Mr. Squire.

(*ii*) *Restricted planting season.*

The meeting recommended that a restricted planting season not exceeding two months in duration, should be strictly enforced in each cotton producing Island, and that wherever necessary legislation be introduced to give effect to this recommendation.

(*iii*) *Close Season.*

The meeting recommended that the annual close season for cotton should not be less than three months in duration and that wherever possible the period should be extended to four months.

(*iv*) *Fumigation of cotton seed.*

The meeting accepted the fact of the gross inefficiency of the great majority of carbon bisulphide fumigatoria now in operation in the various Islands and recommended that wherever possible Simons Patent Heaters should be installed for the purpose of destroying pink bollworm and other insect pests in cotton seed.

(*v*) *The condition of ginneries.*

The meeting recommended that immediate steps be taken to renovate or so reconstruct ginnery buildings as to preclude the possibility of infested seeds falling into cracks or crevices or collecting under the floors of the buildings, and there providing a suitable medium for the existence of resting larvae of the pink bollworm.

(*vi*) *The nature of the fines imposed in magisterial courts on persons convicted of committing an infringement of the cotton sanitation regulations.*

The meeting supported Mr. Squire's contention that the fines imposed on persons convicted of an infringement of the cotton sanitation regulations were in the majority of cases inadequate to serve as a deterrent to slackness and neglect in the proper observance of such cotton sanitation regulations. The meeting therefore recommended that the Governments of the various Islands concerned be invited to draw the attention of magistrates to the harmful effect on the cotton industry, and the menace to social progress which results from failure on the part of one or a few persons in a cotton growing community adequately and effectively to comply with cotton sanitation and close season regulations.

Production in 1938.

Climatic conditions in those Islands where the cotton crop matures in the early months of the year have been more favourable during the growing period this season than during the previous season. Better yields are consequently anticipated in Nevis, Antigua and St. Vincent. In the latter Island, the crop is estimated at 1,100 to 1,200 bales of 400 lb.

The estimated production for the 1937-38 crop as recorded in the minutes of the West Indian Sea Island Cotton Association meeting of November, 1937, is set forth in Table I.

Table I.

SEA ISLAND COTTON PRODUCTION 1937-38.

Island.	No. of acres 1937-1938.	Estimated yield per acre in lb.	Total lint production 1937, in lb.
Anguilla	500	100	50,000
Antigua	2,000	100	200,000
Barbados	Nil	—	Nil
Montserrat	4,300	200	860,000
Nevis	3,000	100	300,000
St. Kitts	2,000	200	400,000
St. Vincent	5,000	100	500,000
Virgin Islands	250	100	25,000
	17,050	—	2,335,000

MARKET NEWS.

Substantial sales of Sea Island cotton were effected in the last six weeks of 1937 at fair prices. Stocks were in consequence much smaller at the end of the year than at the time of the general meeting of the Association in November, 1937.

* * *

The Banana Industry.

In Table II the quantity of bananas sold from the Islands of the Eastern Group of the British West Indies to the Canadian Banana Company in 1936 and 1937 is set forth. With the exception of St. Vincent, where the industry is at an earlier stage in its development, production in 1937 was only slightly in excess of that in 1936. A higher percentage of count bunches was however obtained in all the Islands.

The industry has now been developed to the stage when the quantity of fruit available for shipment fortnightly is slightly greater than the accommodation that can be afforded by the Lady ships of the Canadian National Steamships. The excess is however not yet sufficient to make it worthwhile to the Company to send special ships for bananas. Consequently a number of stems have been purchased by the Company in the several Islands but left for disposal in the local or inter-Island market.

The industry in Trinidad is seriously threatened by the leaf spot disease *Cercospora musae*. In certain areas cultivation has already been abandoned as a result of the ravages of this disease. Unfortunately the disease has recently also been discovered in the smaller islands of Grenada and St. Vincent.

* * *

Arrowroot in St. Vincent.

Total production for the crop year 1936-37 (*i.e.* October 1936 to September 1937) was 7,421,400 lb. or 33,121 barrels of 224 lb. each, as compared with 7,715,456 lb. or 34,444 barrels in 1935-36. The 1936-37 crop had been estimated at 36,000 barrels, but owing to unfavourable weather conditions and a very severe attack of the arrowroot leaf roller (*Calpodes ethlius*) the estimate was not reached.

Table II.

EXPORTS OF BANANAS FROM THE COLONIES IN THE EASTERN GROUP TO THE CANADIAN BANANA COMPANY DURING 1936 AND 1937.

	Trinidad.		Grenada.		St. Vincent.		St. Lucia.		Dominica.		Total.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
Nines	55,033	64,526	48,328	60,321	6,190	14,782	27,230	36,141	27,852	35,671	164,633	211,441
Eights	49,832	50,790	42,868	44,988	10,180	24,208	31,912	40,604	29,448	39,370	164,240	199,960
Sevens	53,844	42,754	51,736	43,890	14,754	24,040	40,036	32,014	34,270	31,232	194,640	173,930
Sixes	376	—	12,636	1,976	3,036	1,316	8,868	648	1,952	88	26,868	4,028
Total Stems....	159,085	158,070	155,568	151,175	34,160	64,346	108,046	109,407	93,522	106,361	550,381	589,359
Equivalent Counts	119,423	123,996	109,506	116,501	21,961	45,287	73,508	82,763	67,556	80,611	391,954	449,158
Percentage Counts	75%	78%	70%	77%	64%	70%	68%	75%	72%	76%	71%	76%

Bananas purchased in 1937 but not shipped

Trinidad	12,757	stems.
Grenada	5,904	,,
St. Vincent	11,142	,,
St. Lucia	17,555	,,
Dominica	27,651	,,
Total	75,009	,,

During the past year or two many estates following the advice of the Agricultural Department have effected improvements in their factories, more especially in connexion with the washing of the rhizomes and in the provision of greater settling space or larger " tables ". These improvements are being reflected in the manufacture of a larger proportion of high grade starch. The proportion of high grade starch manufactured is likely to increase further in the future.

Total exports for the crop-year 1936-37 were 7,836,908 lb., constituting a record for the industry. The previous highest export figure for any one crop-year was 6,578,656 lb. in 1935-36. Owing to the increased exports, stocks of arrowroot in St. Vincent at the end of the crop-year in 1937 were considerably less than at the corresponding time in the previous year.

The 1937-38 crop was also adversely affected by unfavourable weather conditions. There were excessively heavy rains in January 1937 followed by a period of abnormally dry weather. Later in the year, fairly severe leaf defoliation was experienced in some localities. Experimental spraying with colloidal lead arsenate has been very successful in the control of the leaf roller, and it has been demonstrated that an attack may be so completely checked that any further damage is very slight. The total cost of spraying, including the lead arsenate and labour, is stated to be about 5*s*. per acre. This is a negligible amount when compared with the possible losses from the depredations of the pest.

The 1937-38 crop is estimated at about 7,500,000 lb. or 34,500 to 35,000 barrels.

* * *

Brevities.

The Commissioner of Agriculture visited Antigua from 15th to 24th November, 1937.

* * *

Captain H. V. M. Metivier, Government Veterinary Officer, Trinidad, paid a short visit to St. Lucia on 13th and 14th November, 1937.

* * *

Mr. J. M. Cave, formerly Agricultural Assistant, St. Kitts, has been transferred to Nevis as Peasant Agricultural Development Officer.

* * *

Mr. G. A. Jones, Commissioner of Agriculture, accompanied by Mr. J. B. Hutchinson, Cotton Adviser to the Commissioner of Agriculture, visited Carriacou and St. Vincent in January, 1938.

* * *

The Assistant Commissioner of Agriculture visited Antigua from 15th to 26th November and St. Lucia from 28th November to 12th December, 1937.

Mr. E. A. Walters, formerly Agricultural Superintendent, St. Lucia, has been transferred to the post of Agricultural Superintendent in Gold Coast.

* * *

Mr. P. E. Turner, Sugar Cane Agronomist, returned from leave on 12th November, 1937, and proceeded on a visit to Antigua and St. Kitts on 8th January, 1938.

* * *

Mr. E. R. H. Martin has been appointed Agricultural Assistant in the Agricultural Department, St. Kitts. He arrived in St. Kitts on 11th January, 1938.

* * *

Mr. F. A. Squire, Entomologist, Cotton Pest Investigation, Windward and Leeward Islands, returned to St. Vincent at the end of November. Mr. Squire will maintain his headquarters in St. Vincent until the middle of the year.

* * *

Mr. R. G. Fennah, Entomologist, Citrus Pest Investigation, Windward and Leeward Islands, left Trinidad for Dominica on 7th December, 1937. He proceeded to St. Lucia in January 1938, and will remain there for several months.

* * *

Mr. R. E. D. Baker, Mycologist of the Imperial College of Tropical Agriculture, proceeded to St. Lucia on 4th January to conduct further investigations in connexion with the death of lime trees in the Soufriere District of that Island.

* * *

The death is recorded, with great regret, of Alderman H. Astley-Bell, J.P., on 14th December, 1937. He was Chairman of the Advisory Committee in England of the West Indian Sea Island Cotton Association from its inception in 1934 until his death.

* * *

A joint meeting of representatives of the Eastern Group, with one or more representatives of the Western Group, of the British West Indies Fruit and Vegetable Council will take place at the Imperial College of Tropical Agriculture from 9th to 15th February. It is hoped that Mr. C. R. Stollmeyer, Trade Commissioner in Canada for the British West Indies (Eastern Group) will attend the meeting.

A NOTE ON A NEW METHOD OF CONTROL FOR INSECT PESTS OF THE COTTON PLANT.*

By T. G. Mason and E. Phillis.
Cotton Research Station, Trinidad.

The relative toxicity of selenium to plants and to animals has in recent years aroused much interest, particularly in America, where certain soils have been found to contain appreciable quantities of this element.

It has been found [*cf.* Hurd-Karrer (1)] that selenium possesses the unique property of being more poisonous to animals than to plants. Plants to whose roots selenium was supplied were found to be toxic to pigs and rats. Hurd-Karrer also observed that when selenium was supplied to plants infested with aphids, the insects left the plants. In a further paper (2), moreover, it is recorded that selenium was *toxic* to aphids when the concentration exceeded three p.p.m., while with lower non-toxic concentration reproduction was inhibited.

These observations of Hurd-Karrer prompted us to try out the possibilities of using selenized cotton as a trap for stainers and boll-worms. The high cost of selenium and the toxicity to man of plants grown on soils containing this element would, of course, restrict the method to trap crops. The two points on which information was sought were (*i*) the relative toxicity of selenium to the cotton plant and to its insect pests, and (*ii*) whether plants fed with selenium were repellent to the insects. As our enquiry has now reached a stage at which the entomologist could, we think, be of great assistance, we have been led to publish this preliminary note on the results of our work.

We have grown cotton plants (Sea Island) in sand-culture and have used a nutrient solution to which selenium was added in the form of sodium selenate. In each of our experiments we have used five groups of plants: a control receiving no selenium, and the others receiving it at the rate of 5, 10, 20 and 50 p.p.m. respectively.

Growth was strongly depressed in the 50 group, but was only slightly affected in the 20 group. No effect was observed in the 10 and 5 groups. All groups flowered and ripened bolls. The symptoms of selenium poisoning were reddening of the veins, petioles and stems. There was also a tendency for the leaves to be chlorotic. During growth it was noticed that aphids were very prevalent on the controls, but few, and only adults, were seen on the selenized plants. Our observations do not support the conclusion that the plants were repellent, but indicate rather that infestation was maintained at a very low level by the death of adults and the inhibition of breeding.

Cotton stainers (*Dysdercus howardi* Ballou) of the fourth and fifth nymphal stages were fed on green bolls. Within a period of three weeks all the insects on the 10, 20 and 50 groups were dead, while 60 per cent. of the 5 groups were also dead. In the control there were no casualties. Copulation took place in all groups except the 50, but eggs were not seen in the 10 and 20 groups. Thus bolls can be rendered poisonous to stainers by means of selenium supplied to the roots.

In the second experiment nymphs of different ages were fed on seed from the 20 group. It was found that as development proceeds the stainer becomes more resistant to selenium poisoning.

In the third experiment selenized cotton plants were grown in sand-culture on a platform adjoining a field of cotton. When the field plants were cut down and burnt the stainers crowded on to the plants on the platform, where they died. The mortality was astonishing.

Thus selenized cotton plants are not repellent. Whether they are as attractive as normal plants remains to be ascertained.

The results of our experiments with the pink bollworm are less conclusive owing to the difficulty found in breeding them in captivity. The moths do not appear to be repelled by the selenized plants, for oviposition occurred indiscriminately on control and selenized plants. Inspection of plants exposed to bollworm attack showed 39 per cent. damaged loculi in the control, 16 per cent. in the 5 group, seven per cent. in the 10 group, seven per cent. in the 20, and four per cent. in the 50 group. There seems to be considerable mortality in the selenized bolls.

Literature Cited.

(1) Hurd-Karrer, A. M.—"Selenium Absorption by Plants, and their Resulting Toxicity to Animals."—*Smithsonian Report*, 289-301, 1935.

(2) Hurd-Karrer, A. M. and Poos, F. W.—"Toxicity of Selenium-containing Plants to Aphids".—*Science* Vol. LXXXIV, No. 2176, p. 252.

Dr. C. W. Wardlaw's series of articles on the Storage and Transport of tropical fruits and vegetables which was published in Vol. XIV, Nos. 3-12, 1937 of *Tropical Agriculture* has now been issued in the form of a reprint [price 4*s.* 0*d.* (British) and 4*s.* 6*d.* (foreign) post free] which may be obtained from the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

* *The Empire Cotton Growing Review*, Vol. XIV, No. 4, pp. 308-09, 1937.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Velan.

A new compound of exceptional interest to both chemists and textile manufacturers is the subject of an exhibition which was recently housed at Dorland House, S.W. 1. This preparation, which has been given the name "Velan", has been developed during the past three years at the Manchester laboratories of Imperial Chemical Industries, Ltd., as a universal water-proofing agent for textile goods. Information concerning the chemical composition of Velan is not yet available, but it would appear to be a complex organic substance which reacts with both hydroxyl and amino groups and on that account is able to combine with both animal and vegetable fibres. For the impregnation of textiles, Velan is used in the form of aqueous dispersions, which are readily preparable from the substance without the aid of supplementary agents. The impregnated fabrics are dried, and combination between the reagent and the textile fibres is afterwards effected by heating at a temperature of 100°-150°C. It is the last stage of the process which gives permanence to the proofing.

Velan is claimed to be the first water-repellent for textiles which will remain permanent during repeated washing, laundering and dry-cleaning processes. Further, the compound is said to be unique among proofing agents in that it imparts softness and suppleness to fabrics. Unlike rubber or cellulose lacquer water-proofings, Velan does not effect the interstices of textiles and render them impermeable to air. The proofing process has proved satisfactory with cotton, wool, natural and artificial silk, straw, &c., though cotton seems to be somewhat more satisfactory than other textiles from the point of view of the permanence of the proofing. In view of these advantages, and the fact that processing does not add greatly to the cost of manufacture, Velan should find a wide range of applications in the textile industries.—(*Nature*, Vol. CXL, No. 3545, p. 612, 1937.)

* * *

Calcined Phosphate Manures.

The following note forms an introductory section of an article entitled "The Comparative Efficiency of Calcined Phosphates" by Jorge J. Serralles, Jr., which appeared in *Soil Science* Vol. XLIV, Sept., 1937, p. 175. One of the most recent and promising processes for rendering phosphorus in phosphate rock soluble or available to plants was developed in the Division of Fertilizer Investigations, Bureau of Chemistry and Soils, U.S. Department of Agriculture. Briefly, this new process consists in heating phosphate rock to 1400°C. in the presence of 4 to 10 per cent. silica and a reducing atmosphere of water vapour, whereby 95 to 100 per cent. of the fluorine naturally found in rock phosphates can be volatilized, and 85 to 95 per cent. of the total phosphoric acid converted into the citrate-soluble form. Jacob and co-workers, of the Bureau of Chemistry and Soils have shown that fluorine is an important natural constituent of all grades of phosphate rock mined in the United States and in most foreign countries. The fluorine, which commonly ranges from 3 to 4 per cent., may form part of the complex minerals fluorapatite $3\ Ca_3\ (PO_4)_2 \cdot CaF_2$ and hydroxyfluorapatite $3\ Ca_3\ (PO_4)_2 \cdot CaF(OH)$, believed by these authors to be the chief minerals in most phosphatic rocks mined throughout the world. Jacob, *et al.*, and Bartholomew have shown respectively that the solubility and the availability to plants of phosphorus in natural phosphates are lower in types that have a high percentage of fluorine than in types that have a low percentage. Whether the low yield of plants is principally due to the insoluble nature of phosphorus in fluorapatite-like substances, or to a deleterious effect of fluorine on plant growth, is not yet known. Results have been contradictory, but the majority indicate that insolubility of the phosphorus, rather than toxicity of fluorine, is the chief cause of low yields and of unavailability of phosphorus to plants in most raw phosphates. The new calcination process breaks up the fluorine-bearing phosphate compounds into a product the formula of which is not yet known.

* * *

Cobalt and Sheep Diseases.*

In New Zealand, Askew and his co-workers have shown that cobalt plays a vital part in the healthy life of sheep and that small supplements of cobalt salts will cure sheep suffering from a type of anaemia. Sheep on Dartmoor are liable to a disease very similar in symptoms to those described by the New Zealand workers, and the usual practice of farmers is to send their flocks to lowland pastures in the autumn for two or three months.

Analyses of the cobalt content of the soils from moorland pastures on which sheep suffer and from lowland pastures on which sheep have been known to recover give striking differences which are statistically significant:

Moorland soils on which sheep suffer have a mean cobalt content of 3.9 parts per million; lowland soils on which sheep recover, 16.7 parts per million.

The figure for the sickness soils is higher than that given by Kidson† for corresponding soils in New Zealand, where it was found that sickness was associated with soils having a cobalt content of two parts per million. In the Dartmoor district this figure would be about four parts per million, although occasionally samples have a slightly higher content.

Analyses of pastures show that those in the sickness areas have a mean content of 0.20 part per million cobalt and those in the recovery areas 0.45 part per million.

An examination of soil and pasture composition is in progress, and the relationship of these to the incidence of disease is being studied.—*Nature*, Vol. CXL, No. 3539, p. 363, 1937.

* Letter by J. B. E. Patterson.

† Kidson, *N. Z. J. Sci. and Tech.*, 18, 694, 1937.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

The Fractional Liming and Double Heating Process.

The advent of new cane varieties, produced in an effort to increase yields and decrease costs, has resulted in some of the established factory practices proving inadequate. This is because the juices of some of these varieties are in some way different to those of their forerunners and existing factory practices will no longer yield the desired result. The major disturbance has taken place at the clarification station, one of the most important in the whole factory. Without a clear and brilliant clarified juice, the pan work suffers, low grade sugars are difficult to boil, the recovery of sugar falls off and the sugar itself is of a lower quality. It is therefore not difficult to understand why an immense amount of research work has been carried out throughout the sugar world on raw sugar clarification. It has resulted in new processes, new liming techniques, new clarifier designs, &c. Raw sugar clarification must of necessity be simple, cheap and effective. The old method, which is still generally used on easily worked juices, consists of the simple addition of lime suspension to the cold raw juice with subsequent heating and settling. In analysing the mechanism of clarification, there are fundamentally two requirements: (*i*) the coagulation of the colloids, and (*ii*) the precipitation of insoluble calcium salts. The iso-electric point of cane juice colloids, that is the pH value at which they are most easily precipitated, is about pH 5.0. In the cold liming process this fact is not made use of, because the juice is heated at an alkaline reaction about pH 8.2. Accordingly, the pre-liming process was evolved, in which the dose of lime is divided into two, one application to a reaction of pH 6.2 before heating and the other after heating. Theoretically, it should bring about a more efficient coagulation of the colloids for the above reason, but in practice it has not always been successful, either because of the time taken for the muds to settle, or of the large mud volume. While maintaining the essential features of the cold liming process, the addition of phosphoric acid or a soluble phosphate to the juice is carried out to increase the amount of the insoluble calcium precipitate. It is thought that a flocculent precipitate such as calcium phosphate produces a screening action during its period of settling to the bottom of the clarifier. The small flocs or coagulated particles of cane colloid are thereby removed mechanically. Furthermore, there is the actual entrainment of these flocs at the moment of formation of the calcium phosphate precipitate within the juice. That is why calcium phosphate added as such does not have the same effect.

A practical clarification process must also have no undesirable effect on other juice constituents, such as the inversion of sucrose or the destruction of reducing sugars, and it must produce a desirable clarified juice of the correct reaction. If brilliance and lack of colour were the primary desiderata, as in white sugar manufacture, then a more intensive treatment would have to be given together with filtration. Settling, however, is still the cheapest means of concentrating muds for raw sugar manufacture, and the rate of settling and volume of muds are therefore important factors.

The Fractional Liming and Double Heating process (1), which was perfected in the Sugar Technology laboratories of this College, was designed specially for dealing with juices of a refractory nature. Its benefits are relatively not so apparent when used on easily worked juices. The procedure is to add lime suspension to the cold raw juice to a reaction of pH 6.3, then heat to 200°F., add a secondary application of lime suspension to a reaction of pH 7.5, heat to 212°F. and settle. It will be noticed that the primary heating takes place in acid solution thereby ensuring an efficient coagulation of the colloids, but the reaction is not sufficiently acid to induce the inversion of sucrose. The secondary liming is carried out to an alkaline reaction so that a high percentage of calcium phosphate is precipitated and the secondary heating ensures that the reactions are completed. In all the reports so far received, comment has been passed on the rapidity of settling of the muds and the effectiveness of operation when dealing with refractory juices. Some factories estimated that the *extra* increase in juice purity from mixed to clarified juice is of the order of 0.6 over and above the cold liming process. Other reported advantages state a lower volume of mud, a lower consumption of lime, quicker filtering muds and easier working low-grade sugars. In one factory, the secondary liming is carried out with an L & N "Micromax" automatic outfit. The additional equipment required for the installation of the process is well within reason and in some cases merely requires the re-arrangement of existing plant. The current technical literature fully describes these features.

Although only first tried on a factory scale in the Experimental Sugar Factory of the College in the crop of 1936, the process is known to be in operation in factories in Jamaica, Puerto Rico, Antigua, Trinidad and Queensland as standard practice.

1. Davies, Duncan and Yearwood.—*I.S.J.* (1936), 38, p. 298.

ERRATUM.

Vol. XV, No. 1, p. 3, col. 1, line 31. *For* "hormologue" *read* "homologue".

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.).

	Foreign.	*Preferential.*
	s. d.	*s. d.*
25th November	5 10½	9 6¾
2nd December	6 3⅜	10 0¾
9th December	6 0⅜	10 0
16th December	6 1½	9 9¼
22nd December	6 1½	9 10½
30th December	6 1½	9 10½
6th January	6 2¼	9 11¼
13th January	6 1½	9 10½
(*14th January*, 1937)....	6 3	10 0

There was a sharp recovery in prices early in December as a result of some heavy buying by refiners, but this was subsequently followed by an easier tendency due largely to some belated liquidation of the December account. The prevailing mood is one of caution and the subdued tone is characteristic of the present season of heavy Empire arrivals. Although the absorption of sugar throughout the world has generally been well maintained, it is feared that there may be some consumption losses in China, and future price trends will depend on more precise indications as to the actual supply and demand situation during the current quota year.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	Pence per lb.
24th November	7 1-16
1st December	7 5-16
8th December	7 5-16
15th December	7 1-4
22nd December	7 5-16
29th December	6 7-8
5th January	6 7-8
12th January	7 1-8
(*13th January*, 1937)	10 3-4

As expected the International Rubber Regulation Committee fixed the export quota for the first quarter of this year at 70 per cent. This announcement was followed by an advance in prices, but large liquidations of rubber stocks, which had been withheld from sale pending the decision, held the rise in check. An easier tone has since become apparent which is largely due to nervousness among Chinese dealers in Singapore over the Sino-Japanese conflict. The Far Eastern crisis has also affected American consumption, which for November 1937, fell to 33,984 tons.

* * *

COPRA.—Market dull at £14 for spot and forward.

COCOA.—During the greater part of the past month the cocoa market has been marking time. With trading progressing at a diminished rate, prices fluctuated within a very narrow range. The recent inactivity may be attributed directly to the prevailing uncertainty regarding the possible outcome of the natives' holdup in the Gold Coast where the world's largest cocoa crop is now being harvested. With the turn of the year prices advanced somewhat and Accra is now quoted at 28*s.* 9*d.* and locally $7.25 is paid for plantation cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
26th November	4.64	7.13
3rd December	4.65	7.08
10th December	4.70	7.09
17th December	4.81	7.21
24th December	4.82	7.31
31st December	4.80	—
7th January	4.97	—
14th January	5.02	—
(*15th January*, 1937)	7.20	10.26

There have only been minor fluctuations in raw cotton rates, which are tending to be firmer. The revised crop estimate of the American Government at 18,746,000 bales was about equal to expectations, and has not affected the market much. Merchants have also been nervous owing to the uncertain political situation. West Indian Sea Island is quoted at 19*d.* to 21*d.* per lb., but only small lots have been sold, and recently there has been little enquiry.

* * *

BANANAS.—There has been a reduction in demand in view of the cold weather. Prices for Jamaicas are unchanged at £17 5*s.* delivered London, £17 nearest station Provinces. Brazilians are slow at £13 delivered London and £14 Provinces.

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed continues quiet with the value nominal at 32*s.* 6*d.* to 35*s.* There is very little inquiry for Distilled with sellers at 25*s.* *Lime Juice.*—There is no demand for Concentrated and Raw continues to be quoted at 1*s.* 9*d.* to 2*s.* 3*d.* according to quality.—(*West India Committee Circular*, 16th December, 1937.)

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